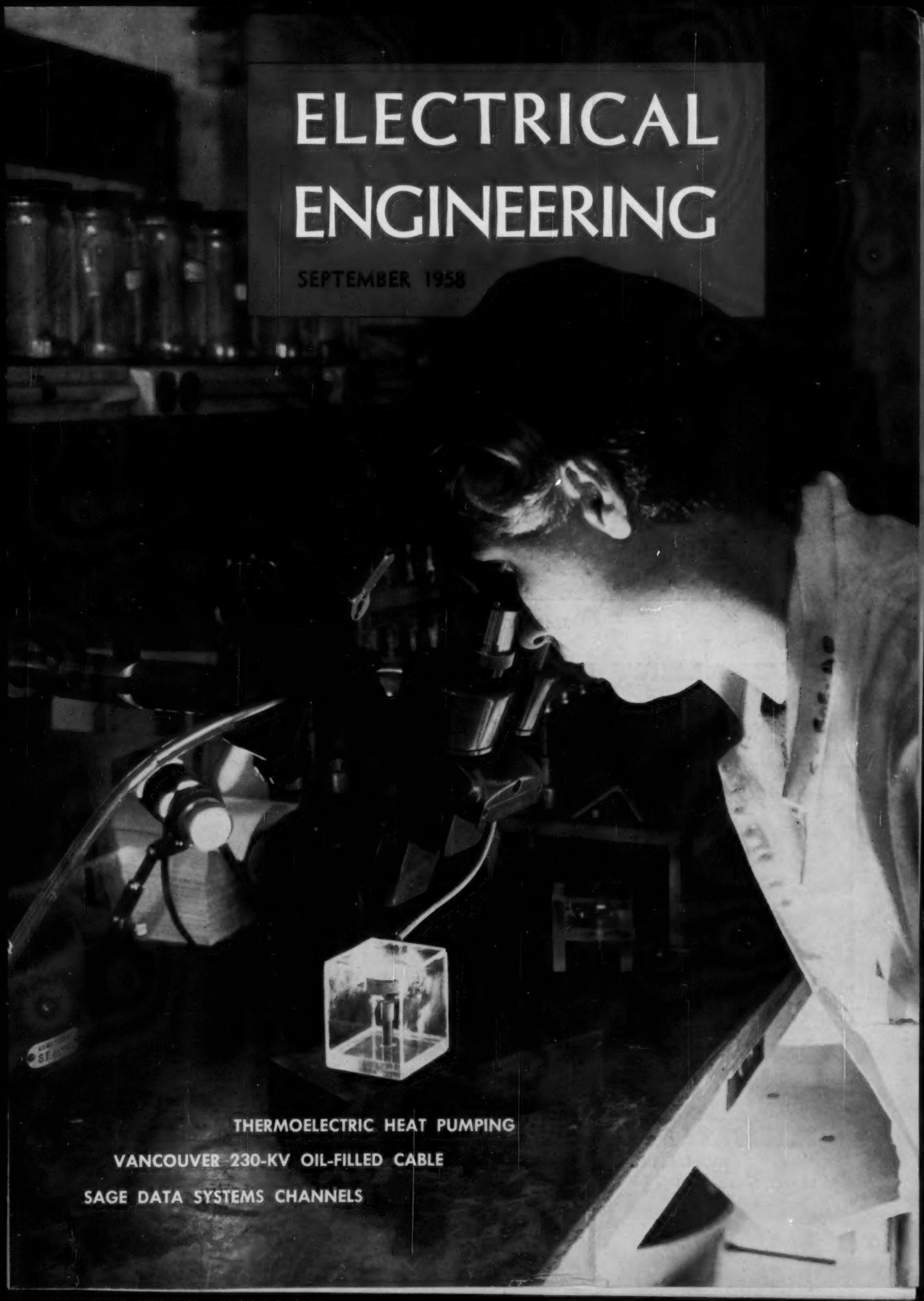
ELECTRICAL ENGINEERING

SEPTEMBER 1958



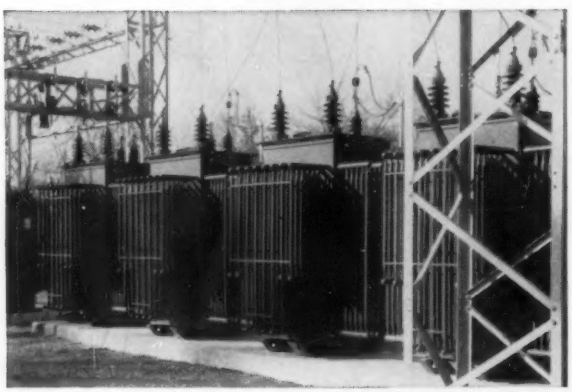
THERMOELECTRIC HEAT PUMPING

VANCOUVER 230-KV OIL-FILLED CABLE

SAGE DATA SYSTEMS CHANNELS

Mr. W. H. Brown, right, reviews plans with Kuhlman salesman, Andrew H. Baxter.

"EXCELLENT PAST EXPERIENCE . . .
that's why we specified Kuhlman"



Doswell, Virginia looks ahead. When planning this four Kuhlman power transformer substation, approximately 50% reserve capacity was allowed for future growth.

"We particularly like the design of Kuhlman transformers," says W. H. Brown, Manager of the above installation at Doswell, Virginia.

"They are rugged in construction and generously provide all the features we consider important.

"We are also impressed with their height, which solves our problem of maintaining required ground clearances.

"Then, too, delivery was according to schedule which, in itself, is no little consideration."

This installation of three Kuhlman single phase power transformers, plus a spare, serves the growing rural and small industrial community of Doswell, Virginia. Although some of the load is polyphase, single phase units are used rather than three phase to give greater versatility for serving the system's single phase farm and residential lines.

Like Mr. Brown, you'll find Kuhlman small power transformers meet all your requirements —especially those features important to you.

KUHLMAN POWER TRANSFORMERS

KUHLMAN ELECTRIC COMPANY General Offices: Birmingham, Michigan

BAY CITY, MICHIGAN • CRYSTAL SPRINGS, MISSISSIPPI • SALINAS, CALIFORNIA

ELECTRICAL ENGINEERING

SEPTEMBER 1958
Vol. 77, No. 9

Published monthly by American Institute of Electrical Engineers

THE COVER: Technician at Boeing Airplane Company's Seattle, Wash., plant examines a growth of "metal whiskers" on a potentiometer through a stereomicroscope. Crystalline in structure, these growths are found on tin, zinc, and cadmium surfaces. Story appears on page 866.

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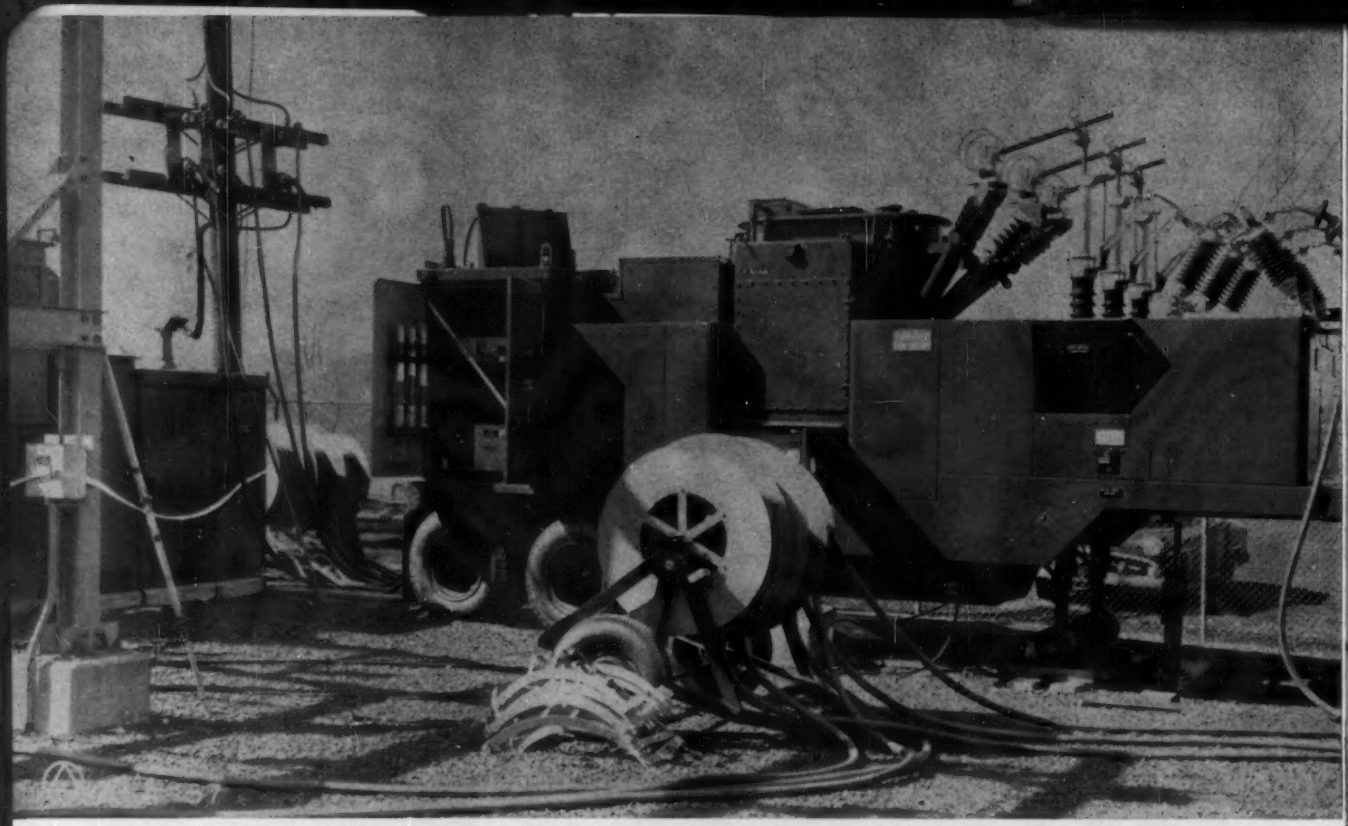


A typical portable substation hook-up utilizing single conductors as recommended by Okonite for portable substation use. Three single-conductor, 5000-volt Okonite substation cables are shown in left background; three single-conductor, 27,000-volt cables on the primary side are in foreground. The three single conductors for each voltage are wound bifilarly on Okonite-designed sectional reels which permit unreeling in two directions at once.

You can reduce substation cutting-in time to minutes by using Okonite-engineered portable cable assemblies

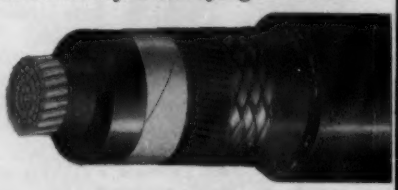
Okonite mobile substation cables provide a compact and functional package engineered to speed up emergency or stand-by substation hook-ups. Cutting in the mobile substation can literally be done in minutes rather than the hours needed with conventional reels, on-the-spot terminations and awkward, heavy cable constructions.

Needed lengths, with permanent factory-molded terminations to fit the customer's needs, are shipped on Okonite-designed reels equipped with clamping devices for the cable terminations and a stand to permit letoff and takeup. Additional features which make this unit fast and easy-operating are a gear drive and a special double-ended winding method, called *bifilar*, which permit both ends of each of three cables to be withdrawn simultaneously. The reel is merely placed at the center of the run and only the required length of cable need be unwound.

Double wind permits both ends of cable to be let off simultaneously.

Designed and built to your needs and specifications, Okonite mobile substation cable and reel assemblies are one more example of Okonite's continuing engineering service to customers.

For more information that will give you totally new ideas on speed and efficiency when tying in mobile substations, ask your Okonite representative or write to The Okonite Company, Passaic, New Jersey.



***where there's electrical power... there's* OKONITE CABLE**

6266

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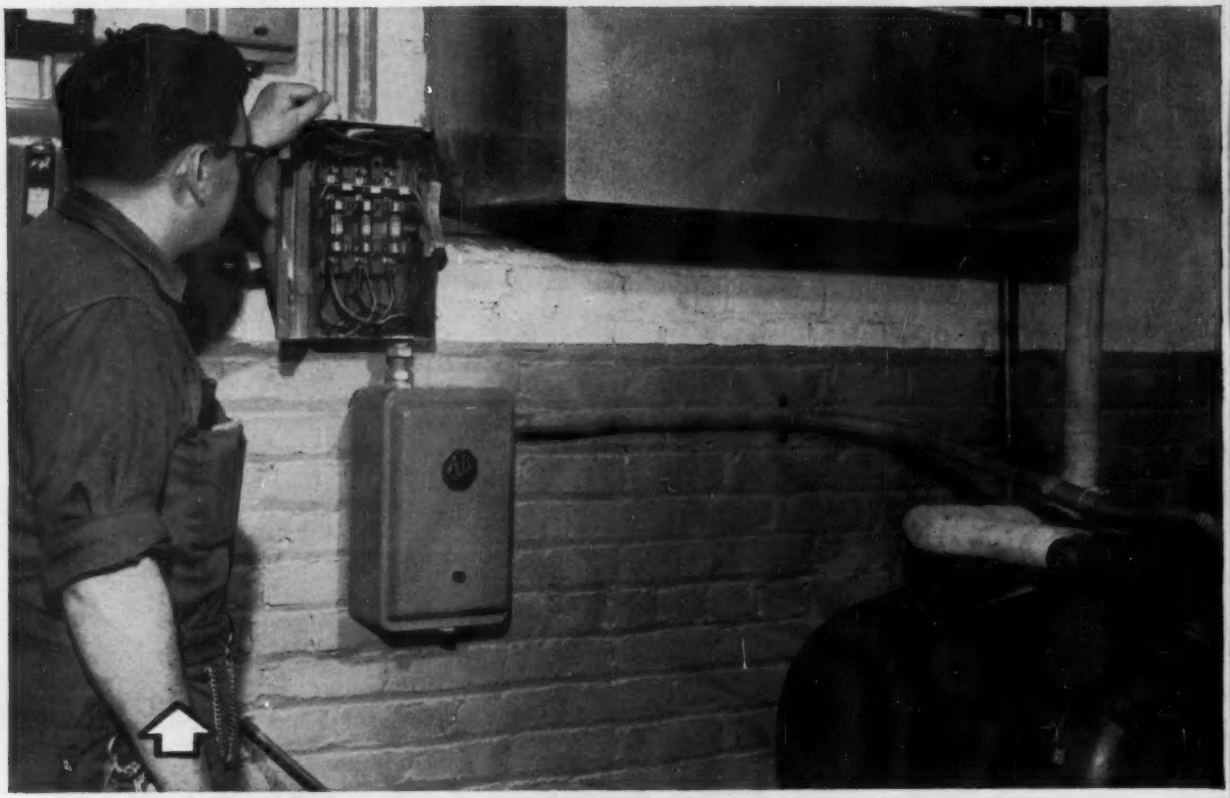


Orville L. Welsh ASST. CHIEF ENGINEER, CONTINENTAL BAKING CO.

"Experience proved to us, Fusetron Fuses could save us money and provide safer protection." . . . *Orville L. Welsh*

ASST. CHIEF ENGINEER
CONTINENTAL BAKING CO.
TOLEDO, OHIO

CASE 1

"A refrigeration compressor of ours was frequently being shutdown because the 60 amp. protection we used just could not hold the starting currents.

"After reading over Fusetron dual-element fuse literature sent to us by our company headquarters, we tried them out with great success. In the past twelve months, we have not had to go near the switch or open its cover.

CASE 2

"In another case, Fusetron fuses saved us a considerable amount of money. We installed 600 ampere Fusetron fuses in parallel in our 1200 ampere entrance switch, rather than using the more expensive mechanical type of protective device.

"Personally, I am confident we now have better protection than we could have had with other types of protective devices."

Here's why FUSETRON dual-element fuses provide safer, more dependable and money-saving protection . . . FUSETRON dual-element fuses provide 10 point protection against electrical troubles. This is unlike circuit breakers or ordinary fuses which, except in rare cases, protect only against short-circuits.

IN ADDITION:

Fusetron fuses require no maintenance or recalibration. They are calibrated at the factory by engineers. Once properly installed, they require no inspection or down-time necessary on mechanically operated devices. There are no hinges, pivots or contacts to stick or get out of order. Dust, corrosion or oxidation cannot increase a Fusetron fuse's capacity or lengthen its blowing time.

After years of inactivity, a Fusetron fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

Fusetron fuses have high interrupting capacity. FUSETRON fuses can safely interrupt severe short-circuit currents and are adequately safe to meet future circuit growth.

Fusetron fuses save on installation costs. Because their long time-lag prevents them from opening needlessly on motor starting currents or other harmless overloads, Fusetron fuses can be installed in sizes to approximate the load current. This protects against waste of space and money by permitting use of proper size switches and panels.

Why Risk Losses! One needless shutdown . . . one lost motor . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing all other types of protective devices throughout the entire installation with Fusetron dual-element fuses.

For Loads above 600 and up to 5,000 amps . . . Use BUSS Hi-Cap Fuses. They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

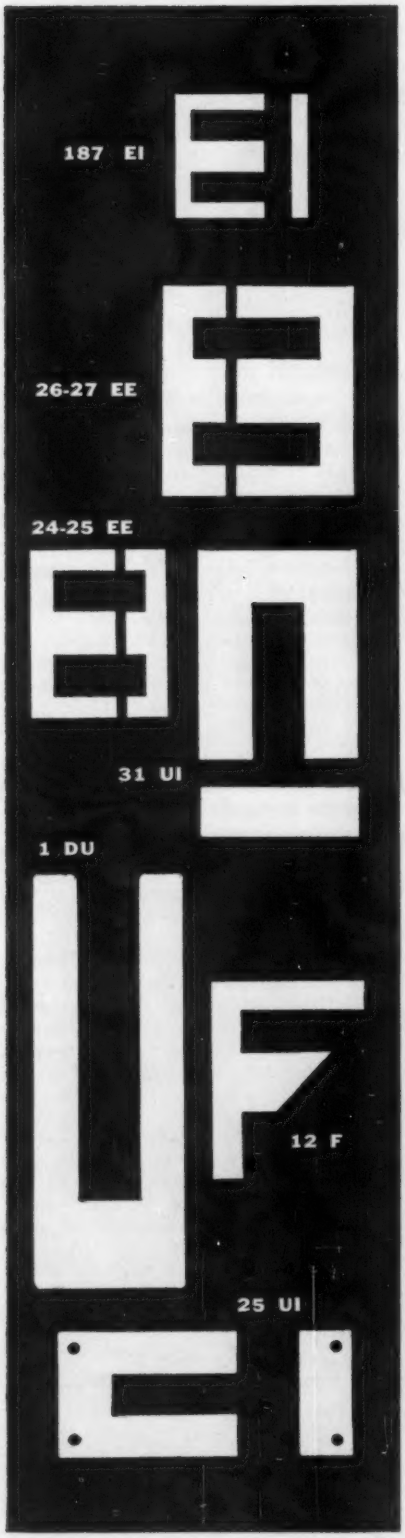
They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

for more information write for } BULLETIN FIS on Fusetron fuses.
BULLETIN HCS on BUSS Hi-Cap fuses.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

for safe, modern money-saving protection install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!

BUSSMANN MFG. DIVISION, *McGraw-Edison Company* **University at Jefferson, St. Louis 7, Mo.**



DESIGNews

Magnetic Metals Company offers a new improved HYMU "80" for higher permeability laminations

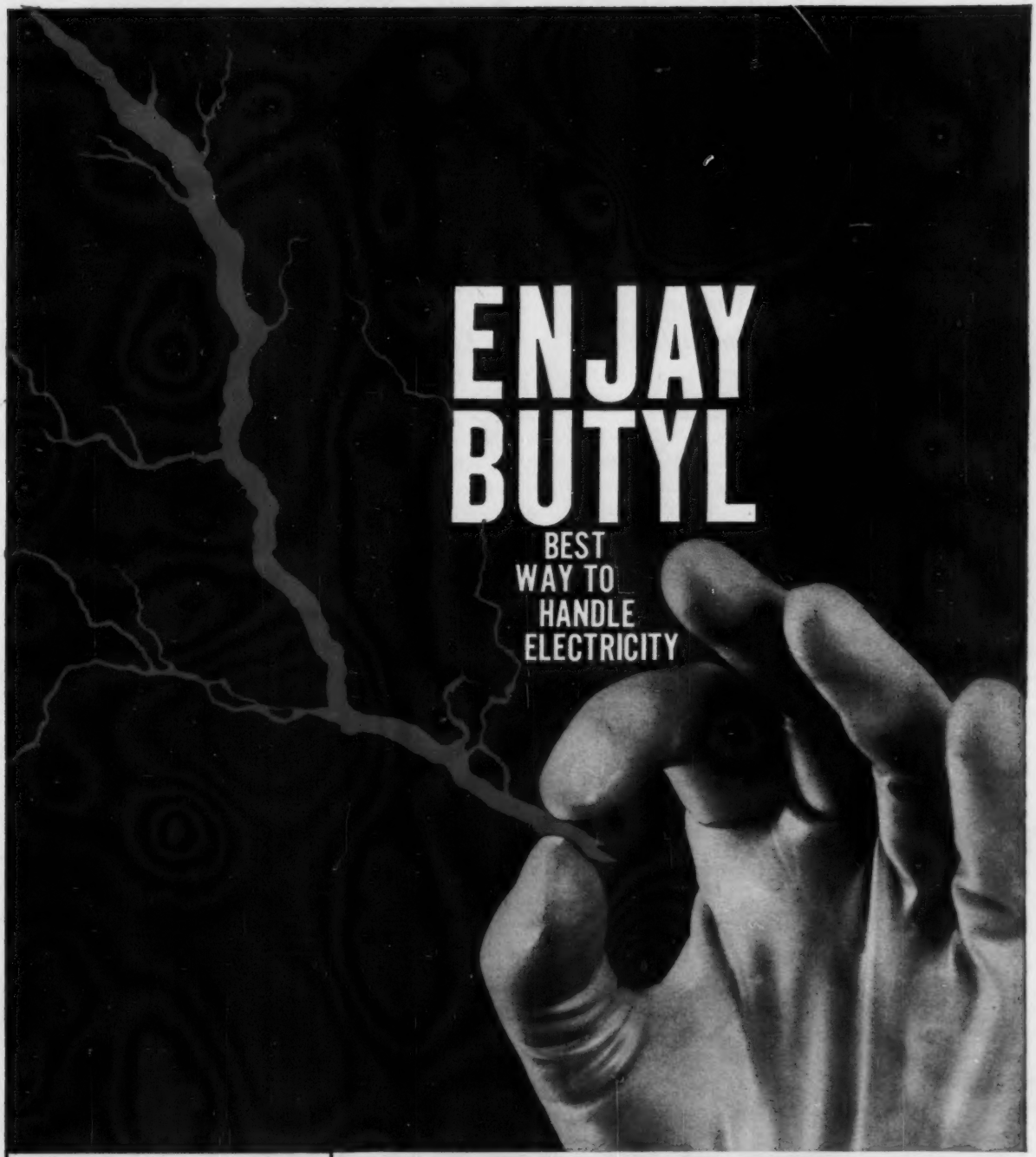
■ Through the use of newly developed magnetic alloys, recently made available to Magnetic Metals Company, laminations of the type shown here are now obtainable in both .006″ and .014″ improved Hymu "80". Permeability rejection levels at low inductions will average 30 to 50 percent higher for these laminations than are now in effect for standard Hymu "80" laminations.

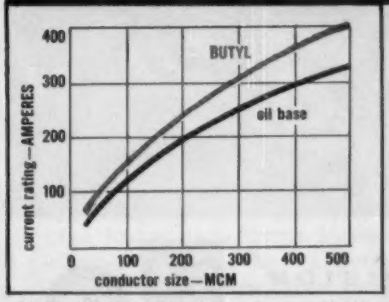
Intensive work on the exacting details of annealing practices, as well as on melting and rolling techniques has made possible these superior characteristics. Stock will be maintained in both .006″ and .014″ material. Prices will be quoted upon inquiry based on quantities required.

Test set-up devised to check low induction permeability.

MAGNETIC METALS COMPANY

ELECTROMAGNETIC CORE PARTS AND SHIELDS • HAYES AVENUE AT 21st ST. • CAMDEN 1, N. J.





Butyl's outstanding resistance to heat allows considerably higher currents for any given conductor size.

Of all vulcanizable rubbers, Enjay Butyl offers the best electrical and dielectric properties. Butyl is the ideal material for wire and power cable, transformers, tapes, busbars and other insulation applications.

Butyl *also* offers outstanding resistance to weathering and sunlight . . . chemicals . . . abrasion, tear and flexing . . . superior damping properties . . . unmatched impermeability to gases and moisture.

Find out how this versatile rubber can improve your product. Call or write the Enjay Company, today!

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750 MCM Single Conductor 91 Strands, 5KV Shielded SUPER-PARARITE PARAPRENE CABLE.

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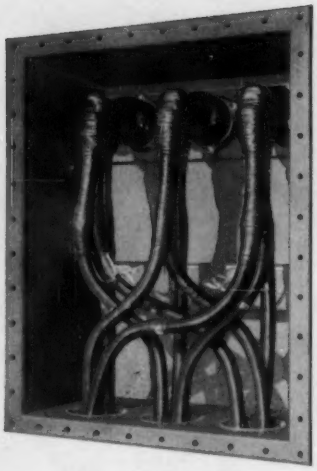
SUPER-PARARITE® PARAPRENE®

CABLE

Installed at Turkey Creek

Here's another example of power—Paranite—and American industry . . . the selection of Super-Pararite Paraprene Cable for the new Turkey Creek Pumping Station at Kansas City, Missouri. The Super-Pararite butyl conductor insulation is recognized for superior resistance to heat, cold, moisture, oxidation and ozone, while the Paraprene neoprene jacket possesses inherent resistance to sunlight, abrasion, ozone, heat, oil and chemicals . . . one of many Paranite products which has earned the industry reputation—"IF IT'S PARANITE IT'S RIGHT."®



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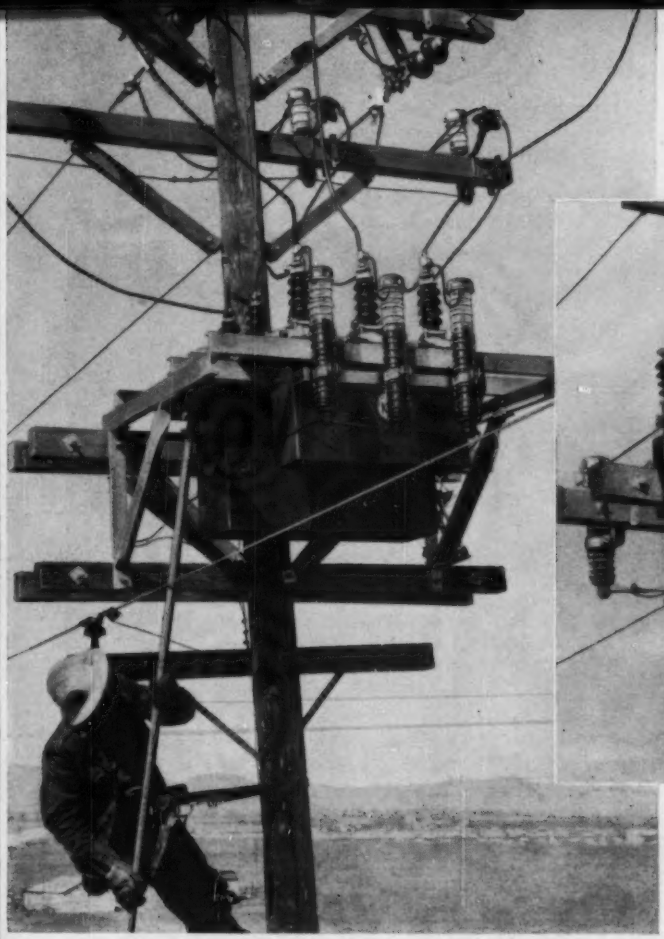
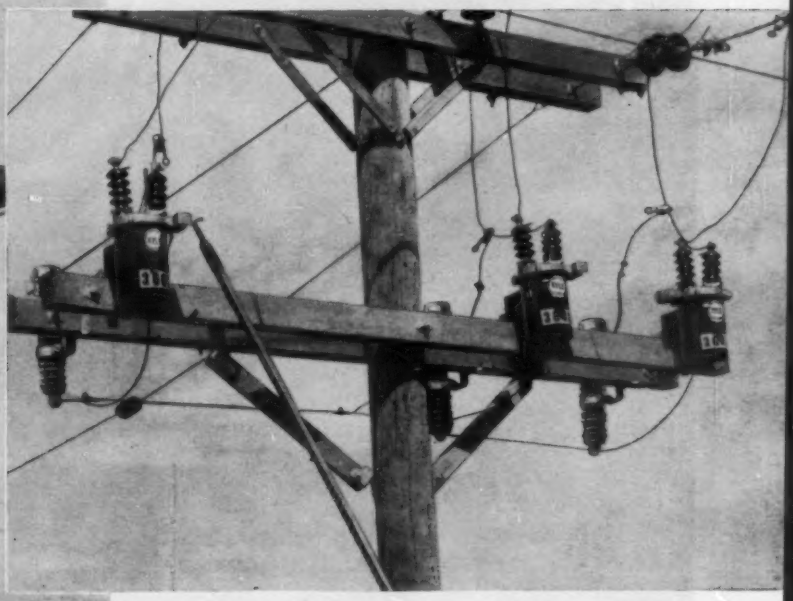


THREE-PHASE 185-ampere Kyle Type R recloser with 200-ampere ground tripping protects the main circuit from faults on a 3-phase branch line in Denver.



THREE 140-AMPERE single-phase Kyle sectionalizers protect the main feeder from faults on short branch lines, and also sectionalize areas behind reclosers. These are operated either by recloser or station breaker.

Report From Public Service Company of Colorado...

Standard Recloser Application Program Conserves Time For Utility's Engineers

Fundamental plan simplifies application of reclosers and sectionalizers; conserves engineering, record-keeping, and storekeeping time; gives better conductor protection.

A standard application plan for reclosers and sectionalizers offers many advantages. With a predetermined program, this equipment is selected and installed according to the plan, without any further engineering.

Basically the plan consists of selecting certain ratings of reclosers and sectionalizers to be applied to branches according to load, line length, and exposure. The plan automatically assures adequate protection against burndowns, gives better assurance of service continuity, and insures coordination.

Public Service Company of Colorado is an outstanding example of a utility with a fundamental protection plan. According to Messrs. Hayden, Martin, and Tilson, electrical engineers for P.S. Company, in the first year "savings in engineering time, record-keeping, and storekeeping have been so obvious as to warrant considerable enthusiasm. Also field experience so far has been most gratifying, because it has indicated that definite and concrete operating benefits have been and will continue to be enjoyed as a result of this plan."

This and other programs provide for complete flexibility. In the original program, any ratings and sequences that engineering prefers are selected. Thereafter the plan is applied automatically. The plan provides for switching or dividing load areas or feeders, and for taking care of increasing loads.

Ask Us For Details

Bulletins on Kyle Reclosers and a copy of a paper on the Colorado plan are available. We'll be glad to supply you with copies. Ask the L-M Field Engineer, or write Line Material Industries, Milwaukee 1, Wisconsin. In Canada: Canadian Line Materials, Ltd., Toronto 13, Ontario.

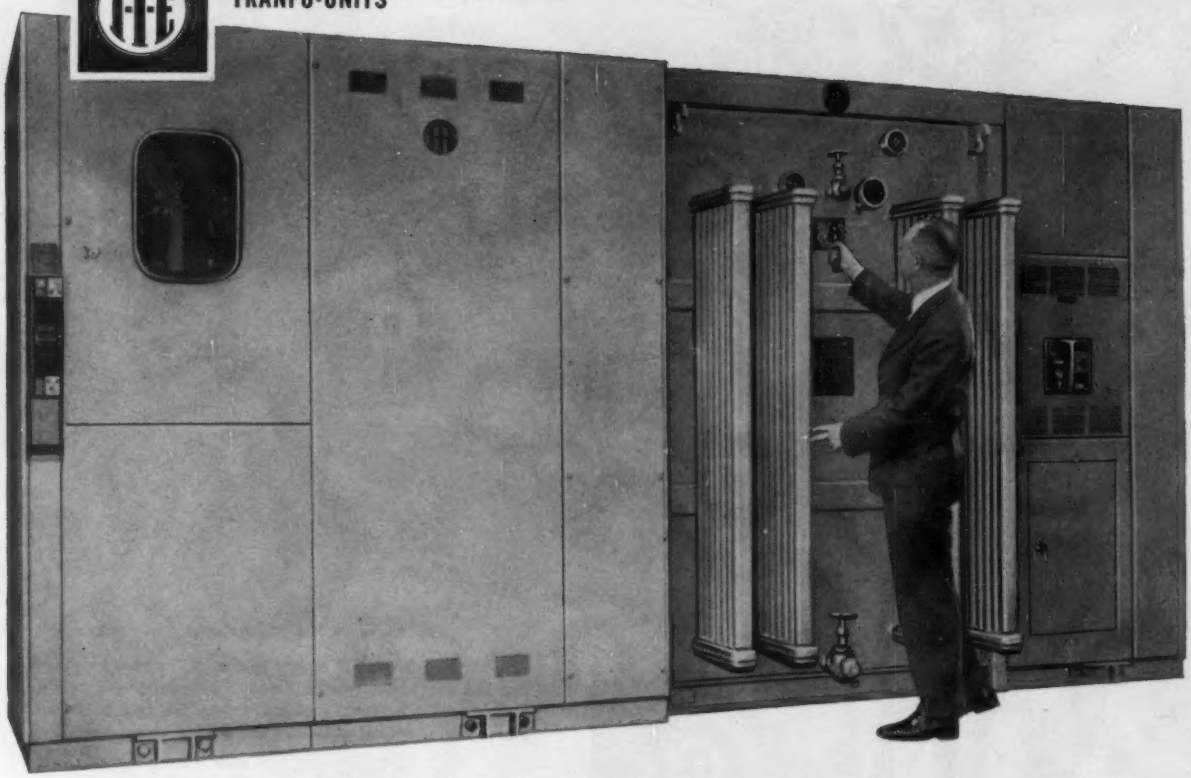
McGRAW-EDISON

LINE MATERIAL Industries Kyle® Reclosers

McGRAW-EDISON COMPANY

317

TRANFO-UNITS



Neat, compact and completely self-contained—a practical, economical way to bring in your electric power at low cost higher voltage.

COMBINES DISCONNECT, TRANSFORMER AND SECONDARY CIRCUIT BREAKERS

More compact than a substation . . . better looking than combinations of loose equipment, yet no more costly . . . here is everything you need in many applications to buy power at economical high voltages.

Every I-T-E Tranfo-Unit is completely assembled and wired at the factory, and no live parts are exposed to contact by personnel. It is normally shipped as a single package. But heavier units are split for easier handling. There is no complicated assembly at the site. You simply position it, connect it, and it's ready for operation. There is nothing else to buy—no additional engineering required.

For supermarkets, schools, office buildings, factories and many other power uses, the I-T-E Tranfo-Unit means new safety, new ease of installation, new improved appearance for power entrance equipment. Available in ratings from 45 through 3000 kva, primaries through 14.4 kv, secondaries through 600 v. For literature, write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY

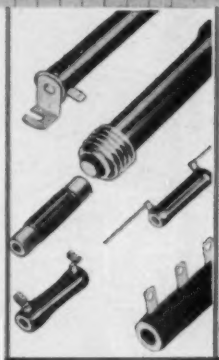
PHILADELPHIA, PENNSYLVANIA

OHMITE® industry's most complete line of WIRE-WOUND RESISTORS

WRITE ON COMPANY LETTERHEAD FOR CATALOG 58

Ohmite has exactly the resistor you need

Ohmite offers the most complete line of high quality resistors on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes and types of terminals . . . in a wide range of wattages and resistances. All-welded construction. Ohmite application engineers will be pleased to help you in selecting the resistors for your job.

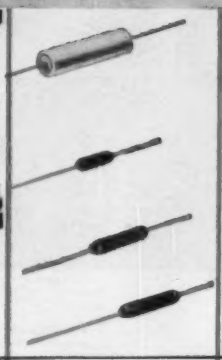


FIXED

Resistance wire is wound on a ceramic tube and protected by a vitreous-enamel coating. Many kinds of terminals available. May be single winding, tapped, or multisection. Watts, 3 to 1000; ohms, 0.1 to 1,700,000.

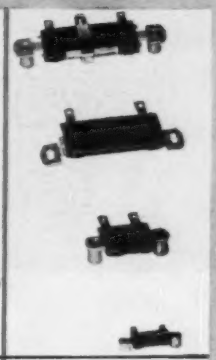
DIVIDOHM ADJUSTABLE

Vitreous-enameled resistors with the wire exposed in a strip along one side for contact with adjustable lugs. Most Ohmite resistors can be ordered adjustable. Watts, 10 to 1000; ohms, 1 to 100K.



AXIAL LEAD

Small vitreous-enameled resistors with wire leads axially welded to caps on ends of the units. Also TUBEOHM ceramic jacketed style. Watts, vitreous 3 to 10; Tubeohm, 5 to 25; ohms, vitreous 1 to 50K; Tubeohm 1 to 25K.

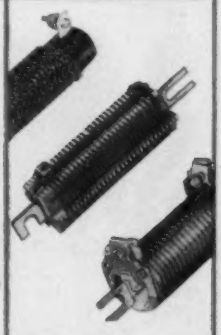


THIN

Resistance wire is wound on a core of flattened oval cross section and protected by vitreous enamel. Several sizes. Fixed, adjustable or tapped. Watts, 10 to 75; ohms, 0.1 to 100K.

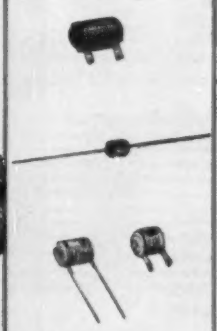
NONINDUCTIVE

Tubular vitreous-enameled resistors with special winding. Dummy antennas consist of assemblies of several resistors. Watts, 5 to 1000; ohms, 1 to 5000.



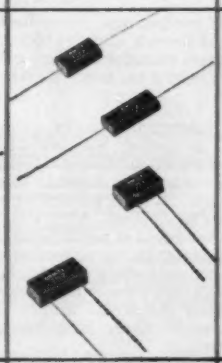
HIGH CURRENT

CORRIBS have exposed corrugated ribbon wound and enameled on a tubular core. POWR-RIBS have bare coil of edgewise wound ribbon or round wire.



PRECISION WIRE-WOUND

Pie-wound resistors, encapsulated, impregnated, or hermetically sealed in glass. Also standard resistors wound to close tolerance. Watts, ⅛ to 2; ohms, 0.1 to 5 megohms.



PRECISION METAL FILM

Consists of a unique metal film permanently bonded to a glass plate. The assembly is sealed in a high-temperature resistant plastic case. Watts, ¼ at 150°C to ½ at 105°C; ohms, 25 to 350K.

SPECIAL VARIETIES

Ohmite can provide toroids, flat strips, plaques, special-sized tubes, or tubes with mixed terminals, etc. Watt ratings and resistances are available as required.

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

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OHMITE®
QUALITY
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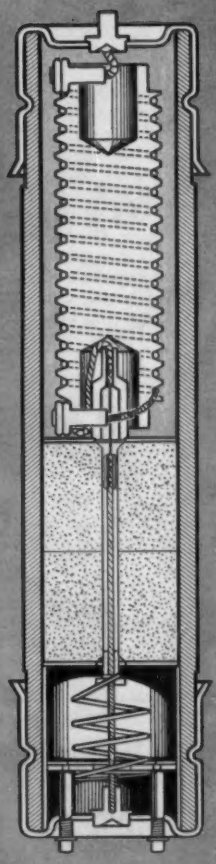
for potential transformers...

S&C's new Fusistor, a universal current limiting fuse



UNIVERSAL because it is not critical as to system voltage. For example, the 14.4 kv Fusistor will take care of all system voltages down to 2.4 kv without impairment of its interrupting ability, and without inducing excessive transient overvoltages during interruption. Contrast this with other current limiting fuses which must be applied between 70% and 100% of nameplate voltage rating.

UNIVERSAL because it fits all mountings, regardless of make. And just two ratings (different clip centers) will take care of most indoor potential transformer protection needs at 14.4 kv and below. There's no need to stock a rating for each system voltage.

HERE'S WHY: The Fusistor interrupts faults even at voltages substantially below its rating because of the inherent operating characteristics of its current limiting section (upper half of cutaway drawing, right). It uses helically coiled molybdenum wire, in turn helically coiled on a ceramic core, embedded in silica sand. Molybdenum has a high resistance even under normal conditions, and when fault current flows, its resistance increases rapidly. Thus, the Fusistor responds immediately to the fault, and—because of molybdenum's high melting temperature—its current limiting action continues longer. And when the molybdenum does melt, there is a less pronounced "chopping" of the current.

In the lower half of the Fusistor is a separate circuit interrupting section. Using time-tested boric acid, it *positively* interrupts even the lowest faults. And on maximum faults, both sections combine to limit and interrupt the current. The Fusistor thus gives positive protection over the full range of fault currents.

Fusistors rated 4.8 kv and higher have two plunger indicators (shown at the bottom of both views) which drop down to show that the fuse has blown.

S&C Electric Company, 4427 Ravenswood Ave., Chicago 40, Ill. In Canada: S&C Electric Canada, Ltd., 8 Vansco Rd., Toronto 14, Ont.

- Power Fuses
- Distribution:—
  - Disconnects
  - Cutouts
  - Fuse Links
- Loadbuster
- Load Interrupters
- Metalclad Switchgear

S&C ELECTRIC COMPANY

THEY MAY LOOK ALIKE—BUT
there is a difference... and the difference is inside, where it counts.

All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied* and tiny (maximum dimensions: 0.265 by 0.107 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as... high back resistance... quick recovery... high conductance... or high temperature operation, *specify Hughes.* You will get a diode with mechanical and electrical stability built in. You will get a diode which was manufactured first of all for reliability.

*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.

For descriptive literature please write: **HUGHES PRODUCTS, SEMICONDUCTOR DIVISION**
International Airport Station, Los Angeles 45, California

HUGHES
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Creating a new world with ELECTRONICS

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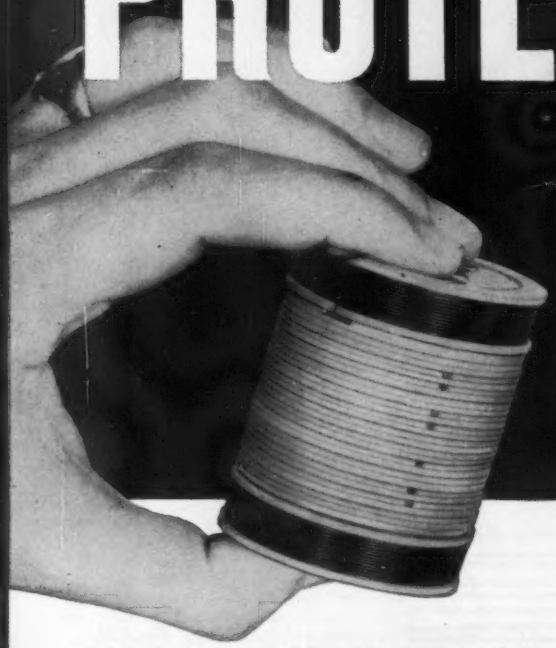
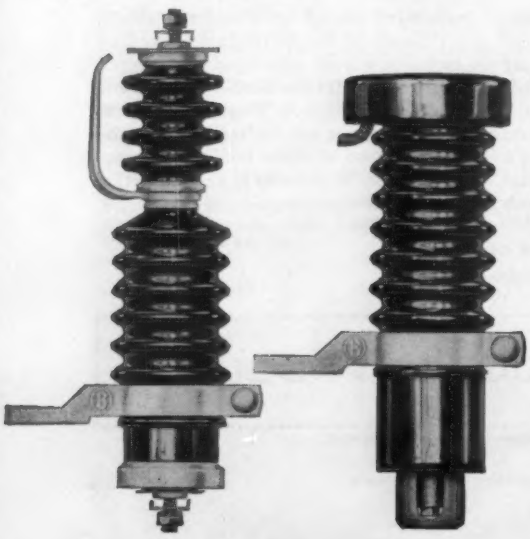
BIGGER PROTECTION

Average Price ★ Smallest Size

Thorex Dynagap Distribution Arresters put Station Quality Protective Equipment on Your Poletops...at no Premium...Conveniently



Used interchangeably in every class of Thorex lightning arrester -- all the way to 350 kv -- the remarkably compact Dynagap element imparts many basic factors of station class protection to your distribution circuits.



Heart of all new Thorex lightning arresters -- the Dynagap element -- is interchangeable in all classes; station, intermediate, and distribution. This puts station quality protective equipment on your poletops. Durability has reached an entirely new order. The arrester can be located, or later re-located anywhere, regardless of load or feeder capacity. With these features that make it big in service protection, the new Thorex Dynagap distribution arrester is physically smaller than any comparable device.

You can install these new arresters on your own pole locations, or specify them as part of any new transformer you order. In either case, they carry no price premium over other valve types.

Change to the new and radically improved Thorex Dynagap and up-grade your distribution arrester protection.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass

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WHEN... storms strike and you must have a reliable source of EMERGENCY POWER

WHEN... you want an installation that demonstrates 2000-3000 cycles of CHARGE and DISCHARGE

WHEN... you prefer a Battery proven year in, year out by continual, on the job PERFORMANCE and not just by accelerated laboratory tests

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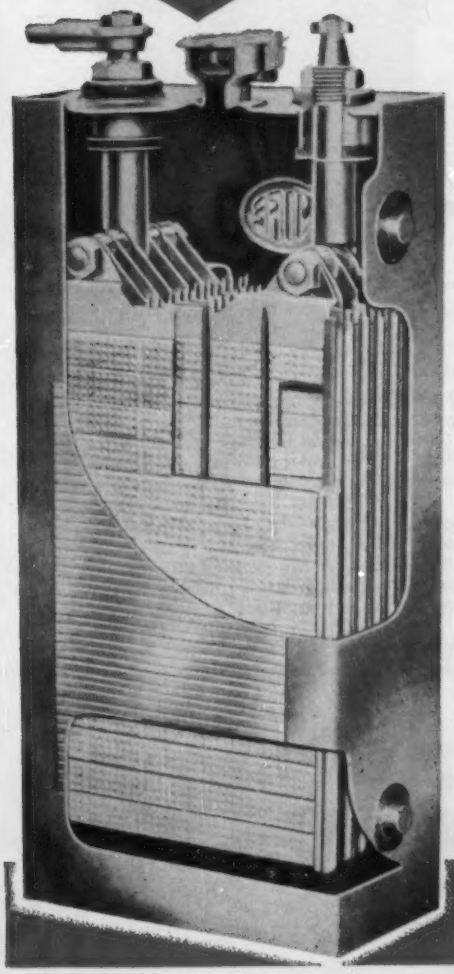
WHEN... your Engines must be cranked by a sure surge of GUARANTEED POWER with NO BUCKLING of BATTERY PLATES

WHEN... you require a Battery that is immune to such abuses as Under Charging, Over Charging, Short Circuiting, Deep Cycling, way below Freezing Temperatures, Excessive Heat, long periods of idle storage with no 'Trickle Charge' and one that is not damaged by shock or vibration



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Announces

DC POWER

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1200 KW Installation consisting of 6 of these units installed at a Government Atomic Energy Facility.

for...

Aluminum, Titanium, etc. Reduction Manufacture of Chlorine, Magnesium, Hydrogen Sodium, etc. Electrolytic Refining of Zinc, Copper, etc.

Ratings to 800 Volts DC and 100,000 Amperes and above

Typical Perkin 100 KW Germanium Rectifier Unit.

PERKIN GERMANIUM and SILICON METALLIC RECTIFIER UNITS have proven to be ideally suited for heavy duty chemical processing applications because of their extremely high efficiencies for low as well as high voltage service, and for their negligible maintenance. There are no special mounting foundations or vacuum pumping facilities required. The units are vibration and noise-free. Also, due to the complete absence of tubes, low ageing and long life characteristics of the rectifiers, and the rugged, conservative design employed, PERKIN METALLIC RECTIFIERS require virtually no maintenance or attendance. The initial installation, plus the long term operation costs are lower than other methods of producing DC power.

In addition to the applications listed, many new chemical processing installations for electrolytic production of hydrogen peroxide, the chlorates and perchlorates, and manganese dioxides are going to PERKIN METALLIC RECTIFIERS in lieu of M-G sets, mercury-arc, or mechanical rectifiers as a result of the above and many other advantageous features.

For operation of heavy duty DC motors, PERKIN has standard 25, 50, 100, 200 and 300 KW METALLIC RECTIFIER UNITS available.

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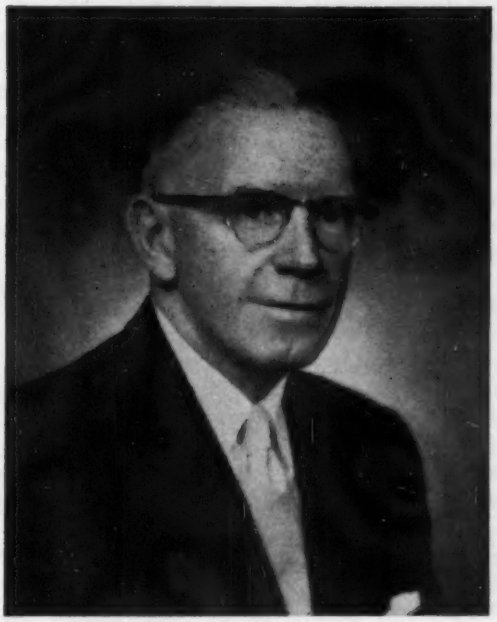


A Year of Progress

W. J. BARRETT
PRESIDENT AIEE, 1957-58

Our outgoing president looks back upon a year of fruitful accomplishments and important developments affecting the future growth of the Institute.

THIS HAS BEEN a very interesting and, I feel, important year in the Institute's history. Let us take a look first at some statistics on Institute operation.

During the past few years, we have experienced somewhat of a slump in the membership growth, whereas from about 1949 to 1954 our membership curve had risen rather sharply, largely due to the greatly increased number of graduates finishing their courses under the G.I. Bill of Rights. During the year just ended there has been a very noticeable improvement; as compared to a net gain of 609 the previous year, this year has shown a gain of 1,655, or 3.3%, which is larger both in number and percentage than in any of the three preceding years.

This improvement is the result of two factors. It is very encouraging to observe first of all that there has been a very substantial decrease in the losses from resignation and death, in fact a drop of 650. Furthermore, we have now begun to receive applications in greatly increasing number from graduating classes, presumably due at least in part to veterans of the Korean War completing their courses. The number of applications from graduating students was 2,375, as compared with 1,503 the year before, an increase of 58%. This brought the total number of applications for admission to the Institute during the year to 4,663, up 22% from the previous year. This is the greatest number of applications received in any year since 1952, and the fourth highest in the history of the Institute. The number of student members on May 1 was 10,592, the largest number of enrolled students since May 1, 1951, when the World War II veterans were in school.

There are now 112 sections and 67 subsections, two more in each category than there were a year ago. This is a normal rate of growth. It is very interesting, however, to observe the tremendous acceleration in the establishment of technical groups within the sections. The analysis of Institute operations which was made with the help of professional consultants a couple of years back resulted in a recommendation for the establishment of more of these technical groups as an aid in best serving the membership at the local level, where attendance at meetings is so much easier and more frequent than at district and national meetings. The year just ended showed an increase in such technical groups from 147 to 223, a gain of over 50%. This is very gratifying, and it is to be expected that this program will grow some more and that the members will derive great benefit from it.

THE SPECIAL TECHNICAL CONFERENCE

ABOUT 10 YEARS AGO, the Institute embarked upon a new form of activity as an experiment. This was the Special Technical Conference. The experiment has been an outstanding success. A Special Technical Conference resembles somewhat a general or district meeting in that it lasts from two days to a week. It is conducted ordinarily under the auspices of one technical committee and is, in many cases, jointly sponsored by other societies. The subject matter of the papers presented is confined to a particular field, and there are usually not more than two simultaneous sessions. This gives the man interested in that particular field an opportunity for a

W. J. Barrett is with the New Jersey Bell Telephone Company, Newark, N. J.

large dose of his subject. The value of these Special Technical Conferences and the interest shown in them is attested by the fact that during the last year there were 27 such conferences with an average registration of approximately 1,000. It is significant to note that the income in connection with technical conferences, from registration fees and the sale of proceedings, has been more than enough to pay for the conferences. In fact, the net income to the Institute from this source increased last year from about $12,000 to almost $23,000. I have made it a point during my term as president to visit 10 of these 27 conferences and I was most favorably impressed by the program and arrangements, as well as by the great interest shown by those in attendance. I am convinced that these Special Technical Conferences have become an extremely important technical activity of the Institute; in fact, the total attendance this year was more than twice the total registrations at all the general and district meetings combined, in spite of the fact that wives and families of engineers were generally very conspicuous by their absence at the technical conferences. I urge most strongly upon the Technical Operations Department that this type of activity be encouraged and expanded because of its obvious great value. Although it is proper that many of these conferences should be jointly sponsored with other societies, and although this increases the attendance figures, I feel that there are a number of subjects in which the Institute could and should conduct additional Special Technical Conferences on its own.

SOME FINANCIAL COMMENTS

YOU HAVE HEARD of the recession. This has, of course, affected the Institute on the financial side. In spite of substantial economies in certain of our operations, our total expenses increased by over 9% while our total income increased only 2.4%.

Publications are a very important part of the Institute business from every point of view. Money-wise, they account for approximately 50% of the gross expenditures, and this year sales and advertising brought in 40% of our gross income. It is obvious that disturbances in their fiscal operations will have a major effect on the over-all financial condition of the Institute. This year, the net cost of publications was over $128,000 as compared with $74,000 the year before. This deterioration of some $54,000 accounts for over half of the $101,000 poorer financial showing of the Institute as a whole this year, compared with last year.

Advertising revenue has been about 30% of our gross income, so it is a very important item. This year there has been an actual reduction in advertising income of $23,000. In addition, the net cost of the bimonthly publications has jumped by approximately $16,000. The bimonthly publications have been, as you know, handled on the basis that a member is entitled to receive any one of the group of three without charge. Additional choices have been billed to him at $2.50 per year. The bimonthlies this year cost us over $165,000 and against this there were receipts from subscriptions of only $28,000. The Board of Directors has decided that this large net cost can no longer be borne without having to contemplate the possibility of another increase in dues before too long. Therefore, it has been decided that effective August 1, 1958, a charge of $2.50 per year will be made for a member's first bimonthly subscription, and $5.00 per year for each additional selection. At the same time, students will be charged $1.00 for the first choice and $2.50 for each additional choice. The price to nonmembers of an annual subscription to each bimonthly will be $8.00.

While we are on the subject of money, I would like to explain something which you may observe if you study the financial statements published in the Annual Report. This year our interest in the real estate assets of United Engineering Trustees (UET) is shown as $265,000 instead of the $498,500 shown in prior years. This does not mean that we have any smaller equity in UET than we had before. It is a matter of realism. The old figure was one fourth of the UET book value of the old headquarters and associated depreciation reserve. The UET's actual present value is substantially higher. Furthermore, in connection with fund raising for the projected new United Engineering Center on United Nations Plaza, the Trustees have acquired substantial additional assets, and these will continue to grow for the next few years. However, in view of the sources and purpose of the contributions for the new Center, and in consideration of the purpose of the contributions made by Andrew Carnegie and others toward the cost of the present headquarters, it is clear that the real estate assets of UET cannot be regarded as the peculiar property of any individual engineering society or societies, but must be regarded as being held in trust for the engineering profession broadly. An exception to this applies in the case of certain monies which have been contributed to UET by the four older Founder Societies out of their treasuries at various times to build up the depreciation reserve fund, and in the case of the cash contribution made by the American Institute of Chemical Engineers (AIChE) on May 1 of this year when it became the fifth Founder Society. We are, therefore, showing on our AIEE balance sheet only the amount contributed out of our treasury, and this is $265,000. It is the same for each of the other three older Founder Societies, and it is $50,000 in the case of AIChE. Recognizing that in a sense these sums are obligations of UET to the contributing societies, the new Founders' Agreements entered into on May 1 of this year provide that commencing with occupancy of the new United Engineering Center, the Trustees will pay interest on these specified sums to the Founder Societies.

NEW HEADQUARTERS PROGRESS

IT IS GRATIFYING to note the progress which is being made toward the realization of the new headquarters building. With funds available, UET has purchased an entire block front on United Nations Plaza in New York

City, between 47th and 48th Streets. Commissioner Robert Moses described this plot to me as "the best piece of real estate in New York City." In connection with assembling the properties to make up this plot of approximately 9/10 of an acre, we received invaluable assistance from both Herbert Hoover and Commissioner Moses. Most of the old structures on the property have been demolished, the remaining two will be demolished shortly, and application has been made for real estate tax exemption on the entire plot in accordance with New York City ordinances.

Fund raising for the new building is proceeding actively. A group of industrialists headed by Dr. Mervin J. Kelly, president of Bell Telephone Laboratories, has volunteered to raise funds from industry and has set for itself a goal of $5 million. Already, they have passed the 60% mark. Herbert Hoover is honorary chairman of this committee.

Member-giving campaigns are in process of organization by all of the societies which will occupy space in the new building. These will number approximately 15, counting Founder Societies and Associates. The goal for this drive is $3 million. Actual solicitation of individual members of all the societies is just beginning, although some hundreds of thousands of dollars have already been subscribed. The general chairman of this drive is Richard E. Dougherty, past president of the American Society of Civil Engineers (ASCE), and the honorary chairman is Charles F. ("Boss") Kettering. The AIEE chairman is Dr. Lester M. Goldsmith of Philadelphia.

A third drive under the chairmanship of William F. Byrne of New York, a vice-president of The American Society of Mechanical Engineers (ASME), is directed toward commerce and industry in the greater New York area. Mayor Robert F. Wagner is honorary chairman.

PAST YEAR FRUITFUL

IT IS HOPED and expected that the new building will be completed about 2½ years from now. The great progress which has been made in this matter during the past 12 months, which have seen the crystallization of plans, the acquisition of the site, and the launching of the fund-raising drives, is one reason why I regard the past year as a very important one in the Institute's history. There are a few other reasons, which I should like to touch upon briefly.

Two years ago your Board of Directors adopted what has come to be known as the "Functional Plan" for the organization of the engineering profession. This was announced for the first time just a year ago in *Electrical Engineering*. Since then, it has been the subject of much discussion, orally and in print, and has attracted a great deal of support in various quarters. It has been endorsed by the Council of The American Society of Mechanical Engineers, and by the National Society of Professional Engineers. By invitation, your president and other officers and recent past officers of the Institute have addressed a number of other engineering societies and groups on the plan. It is our hope that it will, in the reasonably near future, be accepted and put into effect. Every member of the Institute should be interested in this proposal. Although much has been published regarding the plan, not all of it has been accurate. I recommend most strongly to all members who have not already done so, that they read carefully my article in *Electrical Engineering* for February 1958, which explains the plan and clears up certain misunderstandings which had arisen concerning it. Your Board of Directors feels that this proposal, which originated with Past President E. B. Robertson, is the most constructive that has yet been advanced to straighten out the confusion which has existed and to permit the societies to serve the profession and the country more effectively.

Electrical engineering is one of the most rapidly expanding fields of technology. It is no easy matter to administer the Institute in such a way as to give maximum service to members interested in all fields of specialization and promptly take care of the new branches which are so frequently arising. In such a situation, there is great danger of the development of splinter groups. It is the conviction of your Board of Directors that the best course is not through the creation of a multiplicity of new societies in diverse fields but through the expansion of AIEE to keep up with new developments and the establishment of the proper organization and programs within the Institute.

There is more involved here than merely the breadth and depth of our technical program in the newer fields, which we frequently refer to as "electronics." We must consider how to make the Institute, as an organization, attractive to the engineers in these areas, most of them relatively young men, and how to design the structure of the Institute so that these new fields are given a distinct and prominent place and the men working in them have the opportunity to hold appropriate office. This challenge is perhaps the most important that has faced the Institute since the organization many years ago of the Institute of Radio Engineers. To meet it, a special task force has been charged with the responsibility of studying the organization and operation of the Institute in all its aspects and making recommendations for appropriate rearrangements to meet the situation. I shall be surprised if these recommendations, when they are received, are not rather far-reaching.

The cramped quarters in the old headquarters building have placed a limit on the enlargement and proper adjustment of the staff to keep pace with the growth of the Institute and with the ever-developing character and scope of the service to the members. This situation has recently become critical. Anticipating the opportunity that will come with the availability of greater space and more modern facilities in the new United Engineering Center, another special task force was set up to study the staff problem. This group was directed to design an ideal headquarters staff which would be adequate for the immediate future and flexible to permit growth with the Institute; to spell out the duties and responsibilities attaching to each of the supervisory positions in the organization; to enumerate the qualifications of people

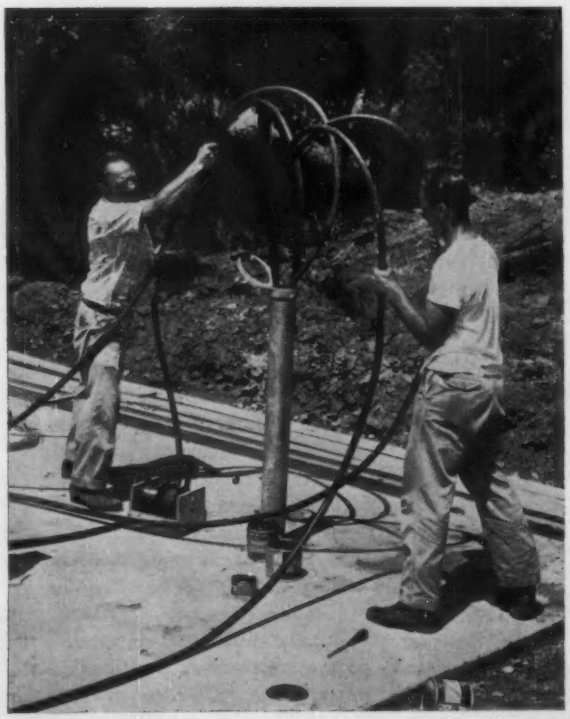
capable of filling these various positions; and to establish suitable salary schedules. This committee will present its report to the Board of Directors this week.

I have had the opportunity this year to do somewhat more traveling on Institute affairs than any of my predecessors since 1950. At that time, the president was relieved of the obligation of visiting the sections and branches. There are just too many of them. This year in addition to the four general meetings and four district meetings, I visited, as mentioned a few minutes ago, 10 of the Special Technical Conferences. Although I do not feel that my presence added very much in total to these affairs, it did seem to be helpful in some degree at several of them. I was motivated by the feeling that they had reached sufficient importance to merit whatever recognition a presidential visit would bring. These visits provided the basis for the evaluation of the Special Technical Conferences which I have already given you. Consistent with my view of their importance to the Institute, I would recommend a continuation of presidential visits to a fair sample of them each year with suitable advance preparation to capitalize on these visits.

I also made visits during the year to 16 sections, 3 subsections, and 10 student branches. With very few exceptions, it was evident that the visit of the president meant a great deal to these local units and gave them quite a boost. I cannot help but feel that occasional repetitions of presidential visits to a section or branch would be stimulating and encourage more active participation by the local members. I would suggest to my successors, therefore, that such visits continue to be made to a fraction of these units each year. I can promise them some very worthwhile and interesting experiences, comparable perhaps to the one I had in Tulsa, Okla., where I was made an Indian Chief and the one in Amarillo, Texas, where I was presented with a beautiful "Texas Fedora." I also have the keys to two cities, presented to me by their Mayors.

This week's meeting marks the close of the major activities of this administrative year. The annual election has been held, the report of the Tellers Committee is here, and it is now time for you to meet those who have been elected to administer the affairs of the Institute in the year beginning August 1.

Mylar Rope



Rope stranded from Mylar, a Du Pont polyester film with remarkable strength properties, may have solved the major electrical contracting problem of pulling cable through conduit. On a recent Pacific Coast project, R. C. Electric Company of Redwood City, Calif., pulled four electrical cables weighing more than 1,200 pounds through a 162-foot length of 4-inch conduit with a Mylar rope only 3/8 inch in diameter.

Obtaining pulling lines that are strong, yet will not damage conduit, long has been a problem facing electrical contractors, according to E. Canete, president of R. C. Electric. His firm had previously tried fiber ropes with some success, but their life span was short with breakage often occurring on the first job when the pull was a long one. Steel cables also were tried, but when the conduit contained a bend, the cable frequently cut the pipe in these sections.

The 162 feet of conduit through which four 500,000 circular mills RHW electrical cables had to be pulled, contained one 90° bend and two offsets. Its first 100 feet was made of Orangeberg pipe, followed by 62 feet of galvanized.

For the job, a 3/8 inch conventional three-strand rope of Mylar was selected, pulled by an electric winch. Mylar in this size is more than twice as strong as corresponding fiber rope.

Insulation Aging in Pure Oxygen and in a Vacuum

L. C. WHITMAN
FELLOW AIEE

OXIDATION AND EVAPORATION are two of the mechanisms by which insulation deterioration have been described. The present tests were made with the idea of showing their relative effects and to study the possibility of acceleration of these effects to give more rapid evaluation of various materials. The materials investigated are black varnished cloth, phenolic impregnated kraft paper, and silicone rubber on glass cloth. These are aged in some or all of the mediums of oxygen, nitrogen, air, and a vacuum. These data are compared with previous data on these and similar materials aged in air and nitrogen.

In all cases, the aging criterion is 60-cycle voltage application at 50% of the initial hot dielectric strength of the insulation at the aging temperature.

In the aging under vacuum, a vacuum of approximately 29 inches of mercury is used. With either the oxygen or the vacuum mediums, nitrogen gas is substituted when dielectric tests are made. This is a safety measure in the case of oxygen and is to prevent failure by creepage rather than puncture in the case of a vacuum.

Fig. 1 shows a summary of the results of these tests together with previous data.

The hours to breakdown at 50% dielectric strength are fairly well established in the vicinity of 1,000 hours but the slopes of some of the curves may be subject to change with additional data.

Fig. 2 shows the effect of insulation thickness for phenolic impregnated kraft paper aged in air, nitrogen, and a vacuum. There appears to be a thickness effect for all of these mediums. The data for an air medium was from previous work and is more extensive, accounting for its more regular variation with insulation thickness.

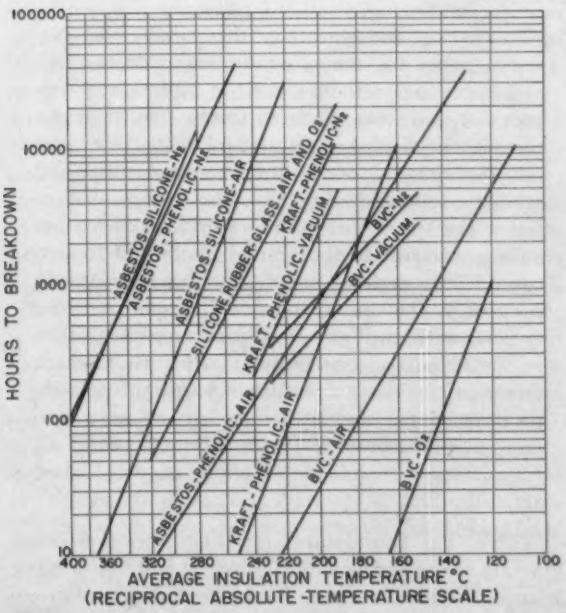


Fig. 1. Summary of life characteristics of various materials in air, nitrogen, oxygen, and a vacuum.

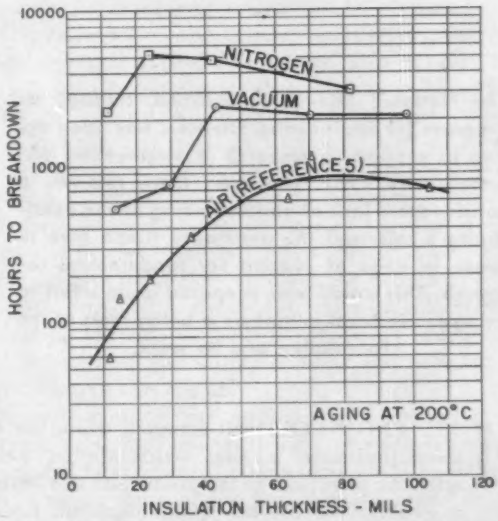


Fig. 2. Life characteristics—various thicknesses—phenolic impregnated kraft paper in air, nitrogen, and a vacuum.

In the vicinity of 150 C, it is seen that materials like black varnished cloth age as much as 15 times as rapidly in oxygen as in air. Alternately, silicone materials do not appear to be appreciably affected by oxygen concentration in the gas medium even when going to the extreme of pure oxygen, because test points for air and oxygen mediums fall on approximately the same curve. Aging in oxygen is thus a very effective method of acceleration of aging tests except for silicones or similar materials.

The difference between the vacuum and the nitrogen characteristics of BVC of Fig. 1 shows the change in evaporation component for a gas pressure change of 20 pounds per square inch, while the difference between the oxygen and nitrogen characteristics shows the change in only the oxidation component since 5 pounds per square inch of gas pressure was used in each of the latter cases.

For the cases tried, insulation life in a vacuum is about one half of its life in nitrogen and several times its life in air.

Digest of paper 58-119, recommended by the AIEE Dielectrics Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y. Feb. 2-7, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

L. C. Whitman is with the General Electric Company, Pittsfield, Mass.

The National Science Foundation
Its Role in Electrical Engineering Research

G. M. NORDBY

R. N. FAIMAN
MEMBER AIEE

The National Science Foundation, through its Program for Engineering Sciences, has been active in supporting research in engineering sciences since 1951. However, there remains a considerable lack of understanding of the Foundation's role and the assistance it can give to those in need of support for fundamental research. This article was prepared in an effort to bring to electrical engineers a better idea of the Foundation and its work.

MOST ENGINEERS will accept a definition of their profession as one which applies basic scientific principles to the production of a better device or product for the benefit of mankind. Essentially, the engineer is an interpreter of basic research to those whose assignment is the obtaining of these useful results. Inasmuch as basic scientific principles usually follow from basic research, most engineers agree that such research is important, but are not sure to what extent they can or should participate in basic research activities. Part of the confusion arises from a lack of understanding of what basic research actually is. Many definitions exist, ranging from the classic "a quest for knowledge having intellectual curiosity as the only impetus" to "what I do is basic—what you do is applied." However, most engineers are practical people, and such definitions appear nebulous and even a bit confusing.

Another approach is to consider what a basic concept is, where it came from, and how it is used. For example, most electrical engineers have been exposed to Maxwell's equations, and some even use them regularly to solve engineering problems. Certainly, Maxwell's equations are concise mathematical statements of fundamental electromagnetic relations, and the recognition of their existence was a major basic scientific breakthrough that has contributed much to the applied work of the profession. Other examples may be chosen from the fields of thermodynamics, mechanics, or material physics, all of which are embodied in the work of the modern electrical engineer. The solution of specific engineering problems using these principles is not pure research, even though it may be of great value to the profession and the world, but the solution of the specific problems would be difficult, if not impossible, without the basic foundations. Actually, very few engineers are working in the truly fundamental areas (in fact, this may also be considered true of many of the scientists in other fields, such as physics, chemistry, etc.).

From its inception, this country has relied primarily upon the basic research of European scientists, and upon our particular skill in developing devices based upon this backlog of information, but now the gap between basic knowledge and its application is narrowing, both in time and in terms of the personnel responsible. For example, the principle of thermionic emission was known 30 years before the commercial production of electron tubes was begun. Compare this development with that of the transistor, which appeared as a commercial device only 3 years after announcement of the basic discoveries.

THE NATIONAL SCIENCE FOUNDATION

RECOGNITION OF THESE FACTS led to the creation of the National Science Foundation (NSF) as an agency for the encouragement of basic research in the United States. For the first time in the history of this nation, Congress approved, in 1950, a special agency to stimulate and encourage basic research and education in the sciences and engineering. The powers and responsibilities assigned to the Foundation by Congress, in part, are as follows:

> "To develop and encourage the pursuit of a National policy for the promotion of basic research and education in the sciences; to initiate and support basic scientific research in the mathematical, physical, medical, biological, and *engineering* and other sciences . . .; to award . . . scholarships and graduate fellowships in . . . the sciences and to foster the interchange of scientific information among scientists in the United States and foreign countries; to evaluate scientific information among scientists in the United States and foreign countries; to evaluate scientific research programs undertaken by individuals and by public and private research groups; to maintain a register of scientific and technical personnel and other ways to create a central clearing house for information covering all scientific and technical personnel in the United States . . ."

Within the Foundation, the Engineering Sciences Program of the Mathematical, Physical and Engineering Sciences Division is responsible for the aiding and stimulating of basic research in all fields of engineering. It has been the experience of the Foundation staff that

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engineers are relatively uninformed as to the activities of the Foundation, despite its tremendous importance to them.

Both in and out of engineering circles, considerable confusion exists as to the definition of engineering science, basic research in engineering, and the relationship of these to the conventional and classic fields of chemical, civil, electrical, and mechanical engineering. From one viewpoint, engineering science cuts across all of the classical engineering areas and deals with the basic concepts common to all, such as electronics, fluid mechanics, physics of materials, thermodynamics, and so on. Also, since the NSF is limited by its enabling legislation to the support of basic research, engineers often ask what place their work can have in such a program of activities. This article has the purpose of informing electrical engineers in particular of the Foundation, its work, and philosophy.

THE BASIC RESEARCH CONCEPT

THE GENERAL CONCEPT of basic research is difficult to convey, and the picture most people have is distorted by the emphasis given in the news to the exceptional aspects of new inventions and developments, often ignoring reference to the fundamental work without which these could not be made. Seldom, indeed, is the term basic research correctly employed (except by scientists) to mean simply the search for new knowledge and a better understanding of the physical world of man and of man's environment. The problem of "basicness" is doubly difficult in the engineering fields because many people, including many engineers, think of engineering, and even engineering sciences, as being wholly within the applied region. The difficulty is that the change from basic research to development is a smooth one with no well-defined dividing line, and the interests of engineers vary across a continuous spectrum from the engineering scientist–researcher to the design engineer. NSF is concerned with the support of engineers mostly at the scientific end of this spectrum. It must be emphasized, however, that "basic research" in the engineering sciences is usually by its very nature "oriented" toward a specific problem; it differs from basic research in the pure sciences by virtue of the engineers' responsibility for the solving of problems within a certain set of boundary conditions. This establishes essentially a "feedback" process from areas which require more fundamental information before their associated applied problems can be solved, and this orientation may be considered a distinguishing characteristic of engineering science research.

Philosophically, basic research has been defined as a quest for knowledge with intellectual curiosity as the primary motivation, but certainly a research-support program could not be administered on this basis. Therefore, some ground rules must be used to evaluate ideas, although each research proposal at NSF is individually considered.

In considering whether a particular engineering study is to be considered "basic," the criteria of time and economics may be applied as a guide. If the problem is required to meet a deadline with a usable and economic result, it is probably not in the category of a basic study. Research in engineering science should advance a field of knowledge and deal with new principles, but emphasis is not primarily on the development of an economically feasible process, device, or product.

Federal agencies and private industry, because of a need to reach a precise objective in a limited time period, usually concentrate their support in those engineers and scientists who have already achieved a reputation, and much of the work supported is of an applied or developmental nature. NSF, on the other hand, is not so limited. In the interest of developing scientists, NSF may support the young untried scientist or engineer and develop him to a point where he will be of more value to the nation, although the excellence of the research proposed is always a primary consideration in providing support. Without the renewing functions of the Foundation, the supply of ideas and men for applied research may dry up.

Because most of the engineering scientists, at the present time, are associated with educational institutions, and basic research enjoys high status in universities, a major share of the Foundation's funds to date has gone to these institutions, either directly in support of basic research projects or indirectly through fellowships awarded to individuals. Of course, an extremely valuable by-product of the research grant program is the training it affords young research assistants under the guidance of experienced investigators.

Electrical engineering, as an area in the broad field of engineering, has within it many sub-areas of wide diversity. To illustrate the range of interests of the Foundation and its grantees, the following typical grant projects have been chosen for discussion in some detail.

RESEARCH PROJECTS

AT CORNELL UNIVERSITY, under the direction of Dr. M. H. Cohen, the electrical engineering department received a 3-year grant for the study of "Polarization Dispersion of the 200 Megacycle Bursts from the Sun." Previous studies at meter wavelengths have shown that the polarized bursts from the sun are composed of a combination of randomly plus elliptically polarized waves, and the basic question as to the mechanism of propagation of a partially polarized radio wave through the corona needs an answer. Dr. Cohen is applying magnetoionic theory which predicts that Faraday rotation of the plane of polarization of a ray will occur during its passage through the corona if there is a longitudinal component of magnetic field. Since the rotation is inversely proportional to the square of the frequency, this rotation will have a large dispersion, 10^{-4} radians per cycle at 200 megacycles. This, in turn, is great enough to "randomize" the polarization partially if the receiver bandwidth is greater than about 10^4 cycles. Inasmuch as the randomization is a function of the bandwidth,

a measure of this function will then determine the dispersion. Funds from the Foundation are being used to secure data from a polarimeter which is capable of measuring total intensity, percentage of polarized signal, and the axial ratio.

The University of California at Berkeley received a grant for research in the electrical engineering department under the direction of Dr. A. M. Hopkin on "Nonlinear Control Systems." This project has as an objective the determination of where and how desired nonlinearities should be added to a control system. Recent work has indicated that in most cases the best compensation for both linear and inherently nonlinear systems may be obtained by the deliberate introduction of nonlinear elements. However, the complexity of the design procedures associated with this process has forced a reversion to linear theory or cut-and-try approximations. Basic nonlinearity types are being studied, and an attempt is being made to generalize and simplify classes of nonlinearities. Statistical approach techniques are being stressed, particularly for noisy systems, but other signal forms are being considered for noise-free systems. The primary performance criteria is minimum error power (minimum rms error), and both mathematical analysis using computer techniques and experimental verification of theoretical conclusions are being accomplished where possible.

The "Back-Scattering of Megavolt Electrons from Thick Targets" was investigated by Dr. John G. Trump and Dr. K. A. Wright of the High Voltage Research Laboratory of the Massachusetts Institute of Technology (MIT) under another grant. Measurements were made of the currents in the back direction from 12 target metals bombarded by monoenergetic electrons in the range from 1 to 3 million volts. The ratio of back-directed electron current to primary beam current was found to vary from 0.53 for 1 million electron volt (Mev) electrons incident on uranium to 0.03 for 3 Mev electrons incident on beryllium. It was also shown that the energy of the back-scattered electron increases with atomic number and diminishes with increasing primary energy.

The University of Arizona received a grant for an investigation by the electrical engineering department under Dr. T. L. Martin and Dr. C. R. Hausenbauer of "Thermionic Ion Generation in Contaminated Air and Other Gases." The phenomenon of thermionic positive ion emission in air at very low pressures is incompletely understood, except for previous work limited largely to platinum filaments. This research extended the area of knowledge by investigating the positive and negative ion currents produced by various metals in clean air and in contaminated air. The effects of filament temperature and electric field intensity at the surface of the filament was also included.

It will be noted that these research projects as supported by the Foundation satisfy the criteria for basic research in the engineering sciences in that they are not directly of an applied nature and may be considered essentially independent of both time and economic evaluation. The Foundation believes that such research is of critical importance to the future of engineering in the United States, since the increasing rate of development of both military and commercial products is eating deeply into the backlog of fundamental knowledge upon which most successful development work rests. The engineering profession in the United States has been second to none in the application of scientific knowledge to practical problems, but has produced little in the way of fundamental knowledge of the "breakthrough" kind.

THE RESEARCH PROPOSAL

THE FUNDAMENTAL INSTRUMENT which the Engineering Sciences Program employs is the research proposal. The proposal is the device by which the scientist initiates a research project by proposing a specific area of study, and includes such items as a brief history of the topic of study, the proposed theoretical and experimental work, a budget, bibliography, and the biography of the investigator. The budget may contain contributions to the investigator's salary, the salaries of graduate assistants, equipment, travel, and other items needed to carry on the research. Upon receipt at the Foundation, the proposal is reviewed by engineering specialists under what is known as the "referee" system. Reviews are obtained from at least one member of the Advisory Panel for Engineering Sciences of the Foundation and, in addition, from a number of engineering specialists in the particular field of interest in which the project falls. Their rating is based on the qualifications of the applicant, the character of the research environment provided by the institution, and the subject of the particular proposal. Over 600 reviewers in the engineering sciences field have contributed their services in the past 5 years by evaluating proposals for the Program for Engineering Sciences. After the proposal has received an evaluation by reviewers and if it is found to be meritorious, it is transmitted on to the National Science Board for approval, and then, if funds are available, is awarded a grant.

The Foundation is proud of its system of panels which operate in conjunction with the referee system. The NSF does not suggest areas of support or direct research because it recognizes the need for diversity of research. In effect, the Program, in large measure, is directed by the profession itself.

The grants themselves are simple and flexible. They are, in a sense, gifts and, consequently, there is a minimum of reports and detailed information requested from the grantee. The Foundation does request a semi-annual financial statement and six copies of any publications that result from the grant. Although a final detailed report is not requested, the principal investigator is encouraged to publish in existing journals. Any equipment purchased through the grant becomes the property of the institution.

Changes in the rate at which research progress is being carried out on a specific project or changes in the

directions of the research lie in the hands of the principal investigator working within the framework of his institution. Changes in the direction of the research and deviation from the original proposal are permitted when the principal investigator feels it is in the best interests of science. There are no rigid deadlines, nor is there any pressure to produce specific desired results or to solve a particular problem. The grants are so designed to make it simple to do research, to enhance the teaching abilities of the investigator, and to fit smoothly into academic life.

CONCEPTION OF THE IDEA

IN SEEKING RESEARCH SUPPORT, the first and most important step is the conception of the fundamental idea. If the basic problem is clearly defined, the remaining steps follow in a logical sequence. However, the importance of clear conception and presentation of the idea cannot be overstated. If the NSF is to give the proposal proper consideration, the idea must be presented so that others can logically evaluate it. In this light, it is not sufficient to indicate a general area in which work is to be done and ask for funds to begin. Such broad approaches are usually indicative of a lack of understanding or concentration on the topic. Because grants from the Foundation are of necessity limited by the funds available, the problems chosen for support are those which are precisely described and on which care and thought have been lavished, so that they pinpoint a problem and a proposal for solution. It is also certainly recognized that the proposed method may not be fruitful and the path to success may be discovered to be in another direction after the research is initiated. The NSF grant is flexible enough to permit the following of the new procedure without prior authorization or subsequent criticism.

Grants for equipment are not considered separately, but may be a part of all research proposals. The Foundation's responsibility for encouragement of research sometimes results in the "seeding" of a new activity at an institution which has competent investigators but lacks the necessary equipment to pursue an area actively without financial assistance. All proposals are carefully screened to assure the most effective use of the funds available considering all the assigned responsibilities.

GRANTS FOR MAJOR FACILITIES

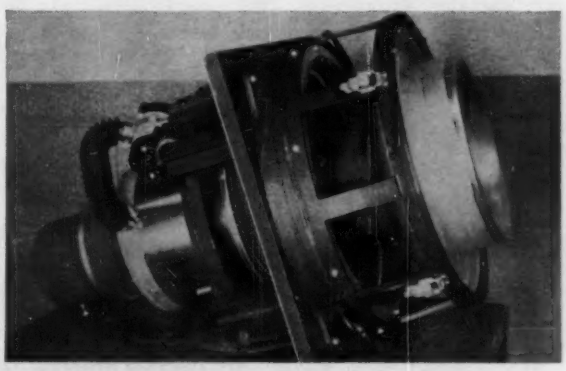
IN ADDITION to grantees with sums for smaller equipment needs, the Foundation has made grants for major facilities in some fields. The radio astronomy facility at Green Bank, W. Va., the reactor facility at MIT, and computer facilities at various universities in the country are examples. The Engineering Sciences Program has been studying and will continue to study the needs for major facilities in engineering both on a geographic and subject basis. Preliminary estimates show this need to be extensive—in the amount of many millions of dollars. However, up to this time, the limited resources of the NSF have permitted the granting of funds only for specifically unique facilities. The Engineering College Research Council of the American Society for Engineering Education (ASEE) presented an NSF-sponsored survey report on the capabilities and potentialities of the nation's engineering colleges at the 1958 ASEE Annual Meeting, Berkeley, Calif., in June 1958. The data of this report will be of great value in the profession's assessment of current and future research support needs.

Other activities which are included in the Engineering Sciences Program are support of conferences and grants for attendance at international scientific meetings.

Engineers recognize the value of small conferences dealing with subjects of limited scope where discussions are extensive. In this case, the Foundation may finance all or part of the expenses as a sponsor or co-sponsor with a scientific society. An example of such conference was a conference on "High Temperature—A Tool for the Future" sponsored jointly by the National Science Foundation, Stanford Research Institute, and the University of California, held in June 1956. This conference, typical in its broad implication, brought together metallurgists, chemists, physicists, and engineers to discuss mutual problems. A conference is initiated by a proposal from a prospective sponsor in much the same manner as is a research proposal.

Detailed procedures for the securing of NSF grants may be found in the booklet "Grants for Scientific Research" prepared by the Foundation and available from the Program Director for Engineering Sciences, National Science Foundation, Washington 25, D. C. Details of other parts of the Foundation's activities not discussed in this article may also be obtained from this source.

1,000-Watt Loudspeaker



This huge loudspeaker, made by the Stromberg-Carlson Division of General Dynamics Corporation for use in high-intensity sound research by the Convair Division in San Diego, Calif., is believed to be the largest single acoustic reproducer ever built. A blower is used to cool the woofer voice coil, designed to operate continuously at temperatures up to 500 F.

Electrical Features of Bay Shore Generating Station

RICHARD MAY
ASSOCIATE MEMBER AIEE

C. M. GARDAM
ASSOCIATE MEMBER AIEE

ELECTRIC POWER is provided by the Toledo Edison Company to a 2,500-square-mile area of northwestern Ohio, which currently demands a peak load of 425,000 kw. This service area is supplied by a 69,000-volt double-belt line loop emanating from the older Acme Station and a 138-kv transmission system originating at the new Bay Shore Station, located on the south shore of Maumee Bay, just east of Toledo.

In accordance with modern practice, the plant follows the well-known "unit" system of design. Original planning for this station began in 1951, construction was started in 1953, and the first unit went into commercial service in 1955. Four transmission lines went in service with the first unit, and one more line is being added with the second unit, which is scheduled for start-up in early 1959. The plant site will accommodate seven generating units of present size and 11 outgoing transmission circuits.

The no. 1 and no. 2 machines are single-shaft tandem-compound triple-flow, reheat turbines operating on 932,000 pounds of steam per hour at a pressure of 2,000 pounds per square inch and a temperature of 1,050 F.

Facilities for receiving coal by rail or by water are installed and can be expanded with station growth. Other facilities such as an intake channel, separate screen-pump house, office building, and machine shop were included with the initial construction.

The generators are rated 140,000 kw, at 30 pounds hydrogen pressure, 0.85 power factor, 3,600 rpm, 18,000 volts, 3 phase, 60 cycles, and have gear-driven exciters. A motor driven spare exciter is now installed for the no. 1 unit and will also serve for the no. 2 unit. Static magnetic-amplifier type voltage regulators maintain generator voltage over a no-load to full-load range without operator adjustment. The generators are closely coupled to the main and auxiliary power transformers by isolated-phase metal-enclosed bus.

With reliability and flexibility as keynotes, two 138-kv busses were installed, with each generator connected to both busses through its respective transformer and oil circuit breakers (Fig. 1). Each 138-kv bus has potential transformers connected for metering and relaying and an auxiliary power transformer to provide reserve and start-up power for the station. The 165,000-kva main transformers are 3-phase units and are connected to the 138-kv substation by means of copper conductors spanning 290 feet between the plant wall and the substation.

A full complement of protective relays is installed to prevent fault damage to the major items of equipment. Generator protection includes field ground, loss of excitation, negative sequence, and percentage differential relays. Main and auxiliary transformers are provided with high-speed differential relays to clear the equipment from the system when faults occur in the respective zones. Bus differential protection is supplied for each of the two 138-kv busses. Directional comparison carrier relaying is used as first-line protection on all transmission lines. Back-up directional relaying is provided as well as out-of-step blocking to prevent undesired tripping on power swings caused by remote line faults.

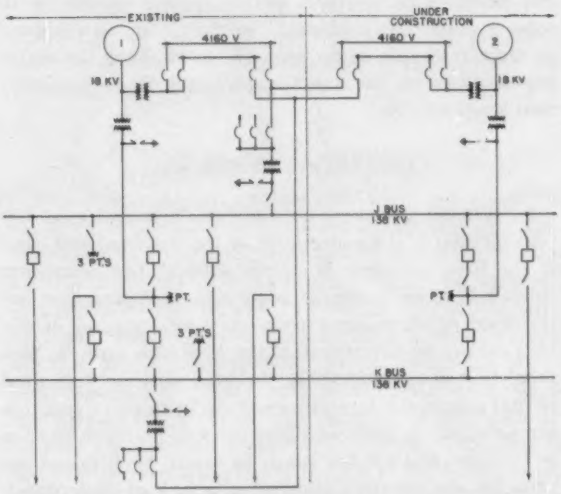


Fig. 1. Station one-line diagram.

The concept of the double-bus arrangement is extended to the auxiliary power system in order to minimize the effect of station power troubles on auxiliary drives. Continuity of service to the auxiliary drives is maintained by an automatic transfer from unit to system sources of power. A comprehensive system of motor-circuit protection is installed to guard the investment in equipment without endangering unit operation with unnecessary tripping.

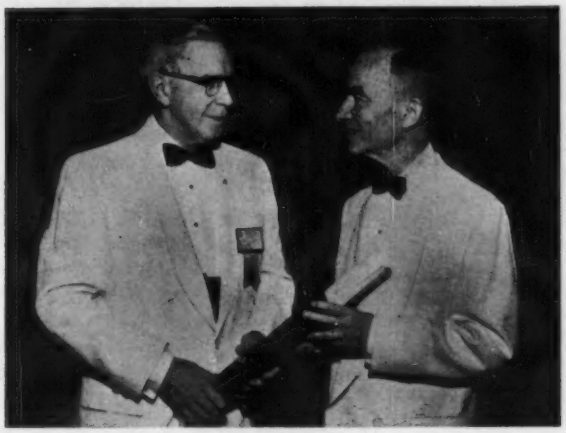
The building lighting system is designed to take advantage of the 480-volt distribution system and to provide minimum illumination throughout the plant with one of the two 480-volt sources out of service.

One 125-volt battery and distribution system is provided per unit with emergency arrangement to parallel two or more units' d-c load. These batteries provide power for relaying, circuit-breaker control, and other critical plant functions.

Digest of paper 58-512, "Bay Shore Generating Station—An Analysis of Specific Electrical Features," recommended by the AIEE Power Generation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Great Lakes District Meeting, East Lansing, Mich., May 5-7, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

Richard May and C. M. Gardam are with the Toledo Edison Company, Toledo, Ohio.

DONALD A. QUARLES
Honorary Member Presentation



DIPLOMA is given to D. A. Quarles (right) by President Barrett, at dinner where the Honorary Member presentation was made.

Distinction in Four Fields

W. J. BARRETT
PRESIDENT AIEE, 1957-58

USUALLY a man is very happy to receive recognition for his accomplishments in a single field of activity. Hon. Donald A. Quarles, Deputy Secretary of Defense of the United States and Past President of the Institute, has achieved distinction in no less than four fields. His career as an engineer and engineering administrator led into his career as a high official of government. Electrically speaking, these two careers were connected in series. In parallel with his career as an engineer were two others, one in civic affairs, the other in AIEE.

Mr. Quarles is a native of Van Buren, Ark. His formal education included attendance at the University of Missouri, a B.A. degree from Yale University, and graduate study in theoretical physics at Columbia University. He has received honorary doctor's degrees in engineering from the University of Arkansas and from New York University, in science from Stevens Institute of Technology, and in laws from Yale University. He has been awarded memberships in the honorary societies Phi Beta Kappa and Sigma Xi. He is a Fellow of the American Physical Society and of the Institute of Radio Engineers as well as of AIEE.

After some experience as a teacher of high school mathematics, Don served during World War I in the Field Artillery of the United States Army in Europe, and was discharged with the rank of captain.

His engineering career began in 1919 with Western Electric Company in the transmission engineering and research department. Later he joined the quality assurance department in charge of apparatus inspection. In 1925, this became a part of the newly organized Bell Telephone Laboratories. Don remained with Bell Telephone Laboratories until 1952, occupying at various times positions as director of outside plant development, director of transmission development, director of apparatus development, and, from 1947, vice-president.

From the very beginning of his professional career, Dr. Quarles displayed those qualities of penetrating, incisive, and inspiring technical leadership which thrust him in the forefront of scientific advance. In the Bell Telephone Laboratories, he directed numerous electronic developments of great moment, including coaxial cable systems for multichannel telephony and television, and military electronic systems which have played a leading role in our security as a nation, both in war and in the prevention of war.

Dr. Quarles has published a number of technical articles dealing with telephone wires and cables and their characteristics, radar, ordnance electronics, fire control, and electronics in air power. He has been granted 14 patents.

While pursuing his career as an engineer and administrator, Dr. Quarles had taken, as engineers should, an interest in civic affairs and had made his time available in the service of his fellow citizens. He became a member and president of the city council in his home community, Englewood, N. J., in 1940. Following this, he was elected mayor in 1946. At the same time, he had been active in county-wide matters and when the board of freeholders in 1945 created the Bergen County Sewer Authority, he became its first chairman.

Don first joined the American Institute of Electrical

Essentially full text of the presentation statement and the acceptance remarks made at the dinner on the occasion of the presentation of an Honorary Member Diploma to Deputy Secretary of Defense Donald A. Quarles at the AIEE Summer General Meeting, Buffalo, N. Y., June 22-27, 1958.

W. J. Barrett is with New Jersey Bell Telephone Co., Newark, N. J.

Engineers as an Associate Member in 1923, while working with the Western Electric Company. He later advanced to the Member grade and then to Fellow. He took an active part in Institute work, especially, at first, in the New York Section of which he became chairman in 1941. In the broader national field, he served on numerous committees and was elected director in 1944. He became President of the Institute in 1952. He has also served on the Board of Trustees of United Engineering Trustees, Inc.

While with the Bell Telephone Laboratories, in 1946, Dr. Quarles' connection with the Department of Defense began when he became a member of the newly established Committee on Electronics of the Joint Research and Development Board. In 1949, he was named chairman of that committee.

On March 1, 1952, Don was made vice-president of Western Electric Company and president of Sandia Corporation, a Western Electric subsidiary which operates the Sandia Laboratory in Albuquerque, N. M., for the Atomic Energy Commission. Sandia Corporation was charged with the design and development of nuclear weapons. Impressed by his performance at Sandia, the Atomic Energy Commission invited him to become its general manager. Instead, he chose to accept the appointment on September 1, 1953, as the nation's first Assistant Secretary of Defense for Research and Development. In January 1954, the Air Navigation Board was reorganized and Dr. Quarles was selected jointly by the Secretaries of Defense and Commerce to be its first chairman. Two months later President Eisenhower appointed him to the National Advisory Committee for Aeronautics.

As assistant Secretary of Defense, he was in charge of a $2 billion a year program of weapons development, including projects relating to chemical and biological warfare, rockets, and guided missiles. He was also involved in the plans for earth-circling satellites.

In August 1955, Dr. Quarles was sworn in as Secretary of the Air Force. This interim appointment by President Eisenhower was confirmed later by the Senate. I would like to quote from an article in the *Saturday Evening Post* by Paul F. Healy:

> "All his background makes Quarles a supermodern managerial type, with extra dimensions. This is fortunate, for running the Air Force is now the biggest operating job in the world. The 16 billion dollars the Air Force is spending this fiscal year is roughly equal to the spending level of the Army and Navy combined. Its 60 billion dollars in assets dwarf the world's largest manufacturing company, General Motors, whose assets amount to a mere 5 billion 3 hundred million dollars. Furthermore, the Air Force labors under the tension of keeping itself in a constant state of readiness for instant retaliation against an aggressor."

Promotion came to Secretary Quarles again when he was sworn into office as Deputy Secretary of Defense on May 1, 1957. In this position, he is the alter ego of the Secretary. In these troubled times, it would be difficult to overstate his responsibility and the importance of the part he plays in safeguarding the American way of life.

In recognition of his distinguished career as an engineer and administrator, his sincere interest in human welfare and service to his community, his outstanding and constructive part in the affairs of the Institute over a long period, and of his dedicated and invaluable service to the nation, the Institute has awarded Donald A. Quarles an honorary membership, which it is now my privilege to present.

The Role of Military Electronics

DONALD QUARLES
HONORARY MEMBER AIEE

IT IS A GREAT PLEASURE to be here with you and I need not tell you how proud I am to receive honorary membership in this great Institute. You have been most generous and I accept the honor you do me with a deep sense of gratitude.

The occasion has a special significance for me when I reflect on the high purposes and objectives of this organization and the momentous contributions which its members have made to our nation's prosperity, to our way of life, and to our national security.

It is like coming home to be with you here, and I am enjoying this first opportunity in several years to participate in an AIEE meeting with so many of my old friends.

Moreover, this brief visit to Buffalo is an enjoyable break in the Pentagon routine. As you have read, things get fairly hectic in Washington at times.

You had many sound reasons for selecting Buffalo for your Summer General Meeting. We in the Defense Department also have major interests in this area. In the Empire State, as a whole, we have more than 100,000 Department of Defense personnel whose annual payroll approximates a half billion dollars.

The Armed Services have almost a billion dollars invested in property at 237 different locations in the State of New York, including 30 major installations.

Our average annual military procurement in New York runs over $2 billion. In the past five months, prime contracts ranging upward from a half million dollars have been awarded to 80 different New York firms, including several in this area. New York's plants are providing many of the highest priority weapon components for our defense establishment.

These activities are of extreme importance not only to this area but also to the whole nation.

I always welcome an opportunity to present to an audience of this kind some of the highlights of our Defense picture. If the ladies will forgive some shop talk, and if I may single out military electronics for some special attention without offending those of our members whose primary interest is in other electrical engineering

Donald Quarles, 1952-53 AIEE President, is Deputy Secretary of Defense, Washington 25, D. C.

fields, I would like to touch briefly on the fantastic role that electronics is playing in the evolution of modern weapons systems. One hears much about guided missiles, nuclear weapons, aircraft, submarines, radars, fire control systems, and many more, but back of all of these and at the heart of their design are electronic systems of ever-increasing complexity and sophistication.

The annual expenditure for development and production of military electronic equipments has grown tremendously in recent years, from around $750 million in 1951 to an estimated $4 billion in 1958.

Such figures are indicative of the level of electronic engineering effort going into these systems. Inasmuch as the ratio of engineering effort to total production dollars tends to be much greater in military devices than in commercial products, it is probable that at least 60 per cent of all electronic engineers in the country are now engaged to some degree on military programs.

Under pressure of requirements for increased performance, cost and complexity of modern military electronics have skyrocketed. Recent advances in the performance of offensive and defensive weapons have forced us to turn more and more to automatic weapon and aircraft control systems in order to escape the limitations of man's senses and physical reactions.

To illustrate, the development and test of the fire control and navigation system for the *F-106* all-weather interceptor cost over $120 million. Ten years ago a development cost of $10 million for an interceptor fire control system would have been considered excessive. At the same time, the electronic components of these systems have increased perhaps a hundredfold in complexity, which in turn creates serious problems of reliability in service and of cost of maintenance.

The development of the electronic navigation system for our new supersonic *B-58* bomber and the delivery of the first test items is costing over $110 million and requiring more than a thousand man-years of engineering effort.

Our recently completed Distant Early Warning network (DEW line) consisting of 58 radar stations across northern Alaska and Canada cost approximately $600 million. Compare this figure with the estimated cost of over $800 million to construct and install our newest radars at only two northern locations to give early warning against ballistic missiles.

Our electronic technology faces a great challenge in the development of a defense against ballistic missiles, because the requirements for computer speed, precision, and reaction time far exceed those imposed on the most sophisticated of our present weapon systems.

With examples of this kind in mind, I am sure the concern over a possible shortage of scientists and engineers is quite understandable.

This reminds me of an amusing observation I heard last week to the effect that, while our population has been doubling every 90 years, our scientists have increased in numbers at the rate of 6 per cent a year. At this rate, there will soon be more scientists than people. I hasten to add that we still need all the scientists and engineers we can get. Let us start worrying about this population problem when we get closer to it.

I mentioned earlier that this great complexity of electronic equipment brings with it the need for greater component reliability. The development of electronic components and equipments to meet great advances in performance, yet withstand extreme environments of temperature, vibration, and stress such as in hypersonic missiles or satellites, is a formidable problem. The military usefulness of a million-dollar weapon can be seriously compromised by poor reliability of a single electronic component. Thanks to the wholehearted support of our laboratories and industries we are making encouraging progress in this field.

After all this shop talk let me turn to a broader subject. We are just at the end of a fiscal year in which we will have invested over $39 billion in defense. Next year, we will probably spend another $40 billion to maintain instant readiness and, at the same time, to modernize our forces and develop and produce the new weapons we must have if we are to stay out front.

Why all this? Because we are in a titanic political, economic, and technological cold-war struggle with a nation whose well-publicized objective is world domination and the elimination of our way of life. In Khrushchev's own words, "We will bury you."

We must either stay in the race with all we've got or face annihilation. We must maintain a favorable position in all these areas of competition, and most particularly in the technological and military, if we are to meet the obligation of free world leadership which has been thrust upon us. This is our challenge.

Last week, we spent three days at Quantico in conference with our top civilian and military leaders. The Secretary of Defense, the Secretaries of the Army, Navy, and Air Force, the Joint Chiefs of Staff and most of our unified commanders were there. We also had visits and talks from other top officials of the Government. I would like to highlight some interesting points developed.

As in your businesses, there is always the preoccupation with budgets. We currently are involved in three major operations—managing the expenditure of past year's appropriations, defending next year's budget and drafting the FY 1960 budget.

The skyrocketing costs of new weapons and increasing operating costs make fiscal planning a tough problem. We must put the money where it will give the greatest defense return. The revolutionary changes brought about by nuclear weapons, missiles, space, and other great technological advances make this a difficult task at best. It calls for wisdom and foresight in establishing our main priorities. These are:

1. Maintenance of an instantly ready, protected, and dispersed air plus atomic retaliatory force.

2. Adequate, modern continental defense system with provision for defense against weapons of the future.

3. Ready mobile forces which, side by side with our allies, can be promptly and decisively used wherever needed, particularly against the "nibbling tactics" at which the Communists have become so expert.

4. An adequate logistic and training support structure and an adequate research and development effort to provide weapons for the future.

I would like to remark on another subject which is being widely discussed in recent months and which received attention at Quantico, namely our capability to deal with small or limited wars.

This is, of course, a complex subject and we do not have time here for more than a few observations about it. At the start, let me say that the subject is surrounded by political questions with which I will not deal. These are such things as how such small wars might start; where and by whom they might be fought; whether in any specific situation there is compelling reason for our forces to participate. Such questions are important to an understanding of the problem but I will limit my remarks to military considerations.

My first observation is that we should define what we mean by a small war. Do we mean engagement of one battalion? A division? A fleet and a division? Five air wings? And whose forces are engaged? Somewhere down the scale it becomes a major conflict. We must have flexibility to meet any situation but our overriding objective must be readiness for this worst eventuality, in case our efforts to hold it to small-war proportions fail.

Second, we believe that our best small-war tactic is to strengthen our allies so that their own forces are strong enough to discourage aggressive moves against them—and, thus, to deter small wars or to stop them before they expand. Our military assistance program has helped to create allied forces, principally ground forces, numbered in the millions, with a great capability in this area.

Third, when and if it has been decided that participation by our forces is required to protect our own vital interests, including our interest in maintaining peace in the world community, we must act with determination. Any impression that we would not do so would increase the risk of the conflagration we must seek by all honorable means to avoid. Courage and determination, and I do not mean provocation, are the essence of the deterrent posture we must strive to maintain.

Last, I believe we have today the required military forces both as to kind and amount to meet these small-war situations—our deployed Army, Navy, Marine and tactical air units, acting side by side with the forces of our free world friends and allies, and backed up by our powerful strategic forces, are, in my opinion, quite capable of coping with any minor engagements, as well as all-out war. We must, of course, be sure to keep them that way.

Let me turn now to some of our important goals in the year ahead of us:

1. Continued acceleration of all ballistic missile research and test programs, including THOR, JUPITER, and POLARIS intermediate range missiles, and ATLAS and TITAN intercontinental missiles. Our objective is to attain the earliest possible operational capability including the delivery this year of the first IRBM squadrons to the United Kingdom.

2. Further improvement of strategic air power with substantial additional production of intercontinental heavy bombers and supporting tankers; procurement of supersonic medium bombers, development of long-range supersonic air-to-surface missiles, and initial development of a future supersonic heavy bomber to follow those we have today.

3. Accelerated development of a system of defense against intercontinental ballistic missiles.

4. Continued modernization of naval units with integration of nuclear power and missiles, plus emphasis on antisubmarine warfare. Particular attention is being given to the POLARIS, an intermediate range, solid-propellant, ballistic missile designed for launching from submarines.

5. Continued modernization of ground forces with provision of the latest weapons and equipments that our nation's technology and production know-how can provide.

6. A strengthening of our Allies through military assistance programs and technical assistance.

7. Improved continental defense with better warning nets, and higher performance aircraft and missiles.

8. Improved personnel efficiency through application of new pay scales and other personnel programs which should reduce personnel turnover, curtail training costs, and improve effectiveness of all Armed Forces.

9. Research and development of still secret weapons of great potential.

10. Advances in the military aspects of space technology.

And, last but certainly not least,

11. The reorganization and streamlining of the Defense Department, in a manner designed to cope with today's fast-moving changes in military strategy and technology, by providing a more effective world-wide command structure, improving the research and development organization in order to be able to move faster on the most important developments, and initiating better team play between the Military Services. To carry out this plan, we must have congressional approval of the defense reorganization proposed by President Eisenhower.

These objectives cannot be met without imposing burdens, even demanding sacrifices, on the part of our people. To many, the reasons *why* we must do these things may seem remote and unreal. To this Institute and to the many gathered here who have played such an important part in this technological race with the communists, I feel sure these reasons are clear and compelling.

Of course, no one wants to accept an expensive and uneasy peace as a permanent way of life. As President Eisenhower has said repeatedly, we must always be seeking arrangements with the Soviets which will ease the tensions and reduce the dangers inherent in this situation.

Until the day when these arrangements and safeguards actually are in effect, our only sound basis for security is the continued maintenance of modern, instantly ready, powerful deterrent forces.

Effects of Arc Voltage on Recovery Voltage

C. CONCORDA

FELLOW AIEE

THE CHARACTERISTICS of the interrupting device may have an appreciable effect on the recovery voltage obtained on interrupting an a-c circuit. This effect may appear as (a) an abrupt cutting off of the current, (b) the introduction of an arc voltage, or (c) the gradual introduction of a resistance. The recovery voltage may be either increased or decreased, depending upon how rapidly the resistance (or arc voltage) increases, and upon when it is introduced.

From calculations made with a linearly increasing arc voltage, the following conclusions may be drawn:

1. There exists a limiting value of the rate of increase of arc voltage above which it is impossible to go, since the voltage across the switch rises only at this limiting rate even when the circuit is instantaneously switched off. This rate is a function of the ratio (x_c/x_l) of capacitive reactance to inductive reactance and of the switching angle (θ_0).

2. For slow rates of increase ($-K/E$) of arc voltage (relative to the ratio (x_c/x_l) of capacitive to inductive reactance) the overvoltage is a function principally of the rate and is almost entirely independent of x_c/x_l. This is approximately true if ($-K/E$) is less than one tenth of x_c/x_l.

3. Conversely, if the rate of increase of arc voltage is relatively fast, or if the ratio x_c/x_l is relatively small, the overvoltage will tend to become independent of the characteristics of the switch and will be a function principally of x_c/x_l and the switching angle, because for small x_c/x_l the limiting arc rate is so small that any kind of arc may be almost instantly put out.

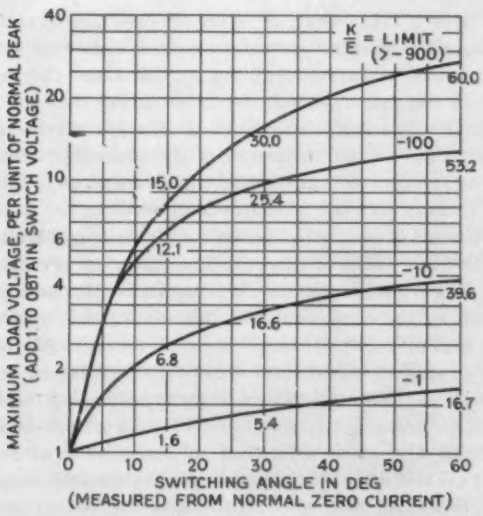


Fig. 1. Maximum load voltage as a function of switching angle, for parallel LC circuit ($x_c/x_l = 1{,}000$).

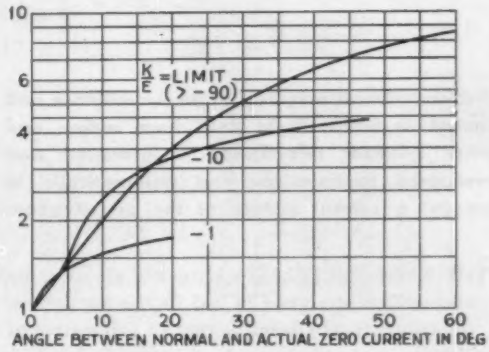


Fig. 2. Maximum load voltage as a function of the angle between normal and actual zero current, for parallel LC circuit ($x_c/x_l = 1{,}000$). Numbers on curves are angles at which current equals zero.

4. For the same switching angle θ_0 (the angle at which the arc voltage begins appreciably to increase) the overvoltage always decreases with decreasing rate of arc voltage build-up, while for the same angle of zero current (the angle which might be most readily observed on an oscillogram of current) the overvoltage may increase, decrease, first increase and then decrease, or be unaffected by changes in the arc rate, depending on the angle and on the ratio x_c/x_l.

From additional calculations made with various shapes of the arc voltage vs time curve, it may also be concluded that

5. The overvoltage increases with the exponent n, where $e_{arc} = Kt^n$, in circuits of high natural frequency and for the larger switching angles θ_0. The overvoltage decreases with increasing exponent for circuits with low natural frequencies and small switching angles.

6. For small peak arc voltages e_a and interruption of current practically at normal current zero, the peak value e_{max} of the natural frequency oscillation is simply increased by the peak arc voltage, thus $e_{max} = E + e_a$.

An example of the results presented is shown in Figs. 1 and 2. The ranges of arc voltages and cut-off angles were extended far beyond the limits that might be encountered in actual circuits in order to emphasize the effects sought.

Digest of paper 58-111, "Effect of Current Cutoff and Arc Voltage on Recovery Voltage," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Published in AIEE *Power Apparatus and Systems*, June 1958, pp. 215-20.

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Communication Channels for SAGE Data Systems

R. T. JAMES

A description of a system of air surveillance and control in which flight data from radars and other relevant information is gathered and evaluated continuously and automatically to present a current picture of the air situation.

THE SAGE SYSTEM is a system of air surveillance and control designed to aid in the air defense of the continental United States. In this system of air surveillance, flight information is transmitted from radars and other sources to a central point where it is processed and evaluated to form a comprehensive picture of the air situation. This picture covers the search area of several radars, thus providing centralized surveillance of a sizable geographic area. The provision of this surveillance capability requires the evaluation of a large amount of information. In addition, to be of any practical use, the surveillance picture must not lag the actual air situation by any very appreciable interval of time. In order to accomplish this, the flight information must be gathered and evaluated very rapidly. This has been accomplished by minimizing the use of human beings in the surveillance system and leaning heavily on automatic methods. The various automatic data units in the SAGE system are, however, geographically scattered and must be interconnected so that they can process and exchange the flight information. This interconnection is made by special communication systems called data transmission systems which will be described herein.

BASIC CONSIDERATIONS

THERE ARE SEVERAL BASIC FACTORS that have influenced the broad concept and ultimate design of these SAGE data transmission systems. First, and foremost among them, is the fact that because of the very nature of the air surveillance problem, the SAGE system always works to some degree in real time. A second factor, so closely related to this as to be almost inseparable from it, is the accuracy with which the whole system must handle the continuous flow of information on which the air surveillance picture is based. A third factor of importance is the sheer size of SAGE. By any yardstick, it is a large project; geographically, for example, it covers the continental United States. Finally, and this is mainly of interest from the communication standpoint, the various data units to be interconnected are usually located in remote and sparsely settled areas.

REAL TIME

IT IS APPROPRIATE, at this point, to amplify the significance of the foregoing real-time factor somewhat, inasmuch as its impact on the design of a data transmission system may not be readily apparent. To those in the communications business, the real point of departure in data transmission system design is not only the type of information to be transmitted (analog or digital), but also whether or not the information is to be transmitted in real time. We use this term "real time" loosely.

Real time is applied rather generally to those data transmission systems and data applications where the information being transmitted or handled has a high rate of obsolescence.

An example of this is the information generated by a modern search radar tracking a particular aircraft. The position of the aircraft is known each time it is illuminated by the radar beam. This position report is obviously valid for just a short interval of time—and the higher the speed of the aircraft the shorter this interval becomes. In fact, the position information is practically obsolete within the time of one radar sweep. The information also has a very limited availability; it is only generated once during the radar sweep for any particular aircraft.

This is a fair sample of what we class as a real-time application. Most military data systems either for weapons control or surveillance are in this class—they vary only in the rate at which the information they use becomes obsolete and in the effects of obsolete or erroneous information on the operation of the over-all system. It will be recognized that the real-time term as used herein has various possible gradations depending on the requirements of the particular system under consideration.

The main effect of this real-time factor on the design of a data transmission system is in the fundamental approach to the error problem. The data information is only available for transmission once, there is only time enough to send it once, and it can only be received once. In such a system, techniques of error correction tend to be of limited utility; techniques of error detection and eventual discard of erroneous information seem more practical and are of correspondingly greater importance. The incidence of errors throughout the system must, therefore, be kept small. In the interconnecting data systems, this leads to the most rugged transmission systems possible consistent with bandwidth considerations

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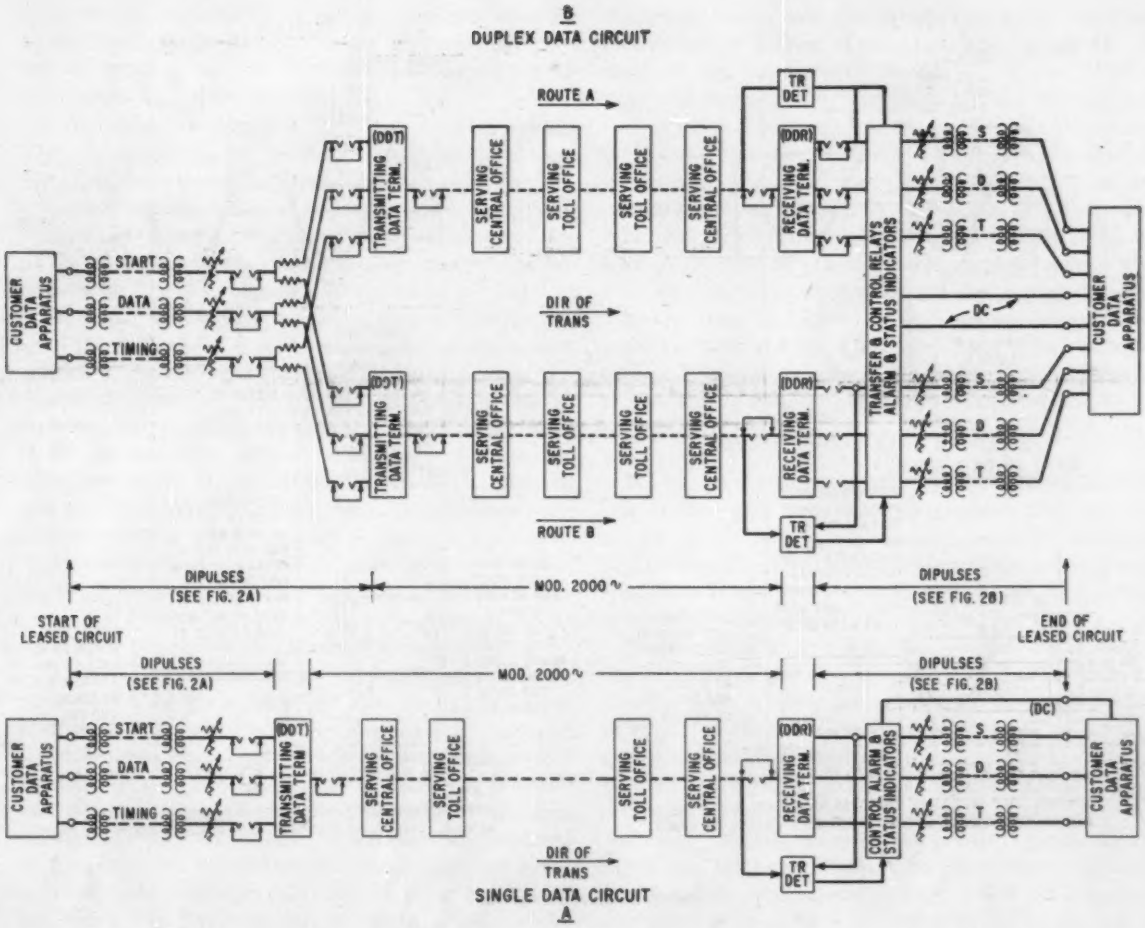

Fig. 1. Data circuit arrangements.

and control of noise in the transmission paths to the fullest extent practicable.

ERROR RATE

At the present time, excluding other connecting weapons systems, there are three main types of data systems used in the SAGE system. Grouped according to use, these are ground-to-ground, ground-to-air and radar data systems. All of these systems do not work in real time to the same degree, neither do they have the same accuracy or error rate requirements. There may be actually two error rates to be considered for any particular system. The first is more or less conventional in that it is intended to be a short-term or minute-to-minute requirement—no more than 1 received error for each 100,000 bits of information transmitted. The second error rate requirement is a longer term consideration and takes the form of a reliability requirement—no system outage or gross system malfunction to exceed 30 seconds.

The first of these requirements has been translated in terms of allowable circuit noise and has greatly influenced the engineering of SAGE data systems. This was an early evaluation of the short-term accuracy requirements; it is now generally appreciated that a blanket error rate of 1/100,000 is a somewhat oversimplified view of things, but it is still reflected in the engineering of all data systems. The second requirement is not applied to all data systems but only those that are very important in the operation of the SAGE system.

DATA CIRCUIT ARRANGEMENTS

Figs. 1A and 1B show the two general data circuit arrangements that are used. (The data circuit terminal apparatus in each case is known as the "Western Electric *A1* Digital Data Signaling System.") Circuit arrangement "A" is used when the 30-second outage requirement is not applicable and normal circuit restoration times are satisfactory. Only one data path is provided; this arrangement is called a "nondual (or single) data circuit." In cases where the 30-second outage limit is applicable, circuit arrangement "B" is used. This is a dual (or duplex) data circuit. Two separate data transmission paths are provided between the data processing

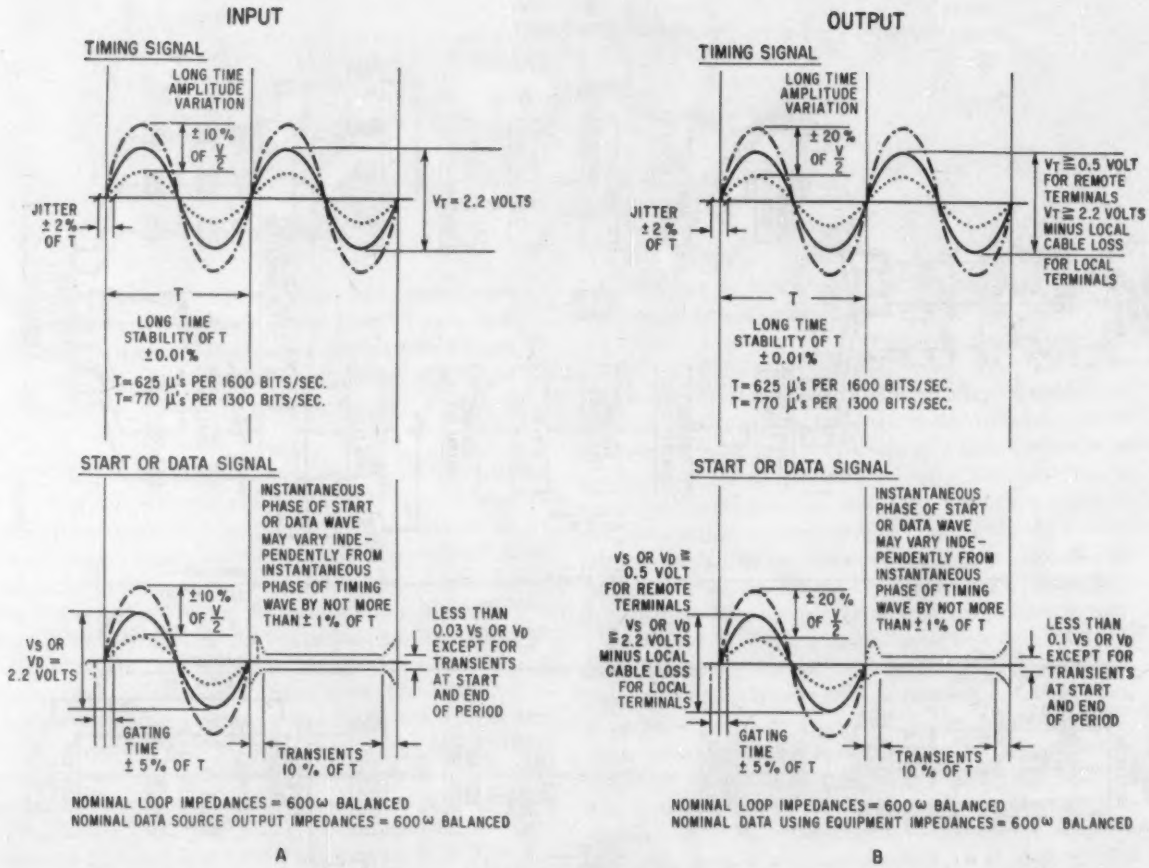
INPUT
TIMING SIGNAL
LONG TIME AMPLITUDE VARIATION
± 10 % OF V/2
JITTER ± 2 % OF T
VT = 2.2 VOLTS
T
LONG TIME STABILITY OF T ± 0.01%
T = 625 μ's PER 1600 BITS/SEC.
T = 770 μ's PER 1300 BITS/SEC.
START OR DATA SIGNAL
INSTANTANEOUS PHASE OF START OR DATA WAVE MAY VARY INDEPENDENTLY FROM INSTANTANEOUS PHASE OF TIMING WAVE BY NOT MORE THAN ± 1 % OF T
± 10 % OF V/2
VS OR VD = 2.2 VOLTS
LESS THAN 0.03 VS OR VD EXCEPT FOR TRANSIENTS AT START AND END OF PERIOD
GATING TIME ± 5 % OF T
TRANSIENTS 10 % OF T
NOMINAL LOOP IMPEDANCES = 600 Ω BALANCED
NOMINAL DATA SOURCE OUTPUT IMPEDANCES = 600 Ω BALANCED
A
OUTPUT
TIMING SIGNAL
LONG TIME AMPLITUDE VARIATION
± 20 % OF V/2
VT ≅ 0.5 VOLT FOR REMOTE TERMINALS
VT ≅ 2.2 VOLTS MINUS LOCAL CABLE LOSS FOR LOCAL TERMINALS
JITTER ± 2 % OF T
T
LONG TIME STABILITY OF T ± 0.01%
T = 625 μ's PER 1600 BITS/SEC.
T = 770 μ's PER 1300 BITS/SEC.
START OR DATA SIGNAL
INSTANTANEOUS PHASE OF START OR DATA WAVE MAY VARY INDEPENDENTLY FROM INSTANTANEOUS PHASE OF TIMING WAVE BY NOT MORE THAN ± 1 % OF T
VS OR VD ≅ 0.5 VOLT FOR REMOTE TERMINALS
± 20 % OF V/2
VS OR VD ≅ 2.2 VOLTS MINUS LOCAL CABLE LOSS FOR LOCAL TERMINALS
LESS THAN 0.1 VS OR VD EXCEPT FOR TRANSIENTS AT START AND END OF PERIOD
GATING TIME ± 5 % OF T
TRANSIENTS 10 % OF T
NOMINAL LOOP IMPEDANCES = 600 Ω BALANCED
NOMINAL DATA USING EQUIPMENT IMPEDANCES = 600 Ω BALANCED
B

Fig. 2. Data system signals.

units. At the transmitting end, both paths are fed simultaneously through a simple resistive network. At the receiving end of the circuit, trouble sensing circuits (TR DET) capable of detecting major circuit troubles control a line switching arrangement that switches the data processing apparatus to the alternate line whenever the working line goes in trouble. A signaling system is also associated with this line switch circuitry that indicates the status of both transmission paths. Line transfers, although they result in a considerable number of errors, are accomplished in well under the 30-second limit. Substantially the same trouble sensing apparatus is supplied with the nondual data circuits excepting, of course, the line switch. In this application, status indications only are available. The actual physical routes used by both types of SAGE data circuits are chosen in accordance with certain military considerations. In the case of dual data circuits, the "A" and "B" routes are widely separate over all but a small part of the total distance between the data processing units.

DATA CIRCUIT CHARACTERISTICS

AT THE TERMINAL POINTS OF THE DATA CIRCUITS, information is exchanged with the data processing units in the form shown in Figs. 2A (Input) and 2B (Output). Three separate informational components exist at these points: start, data, and timing. The start component indicates the beginning of a message, the data component contains the message information, and the timing component provides means of accurately synchronizing the data processing units connected to the circuit.

Data circuits utilized in SAGE are designed to transmit information at two speeds, either 1,300 or 1,600 bits per second. The timing component is a continuous sine wave of either 1,300 or 1,600 cps depending on the bit rate. The message information is carried by a series of marks and spaces on the data path. Marks are indicated by single cycles of either 1,300 or 1,600 cps frequency (dipulses), in the correct time slot. Spaces are no signal. The start of a message is indicated by a single mark on the start path, again a single cycle of either of the aforementioned frequencies depending on the bit rate. Figs. 2A and 2B illustrate a mark-space sequence on either of these last two paths.

At the sending end of the data circuit, the amplitude of the dipulses and the continuous timing wave is nominally 2.2 volts peak-to-peak (p-p). At the receiving end of the circuit, these components can be delivered at substantially the same level if the data processing apparatus and the receiving data terminal are close together. Other-

wise, they are adjusted to 0.5 volt p-p thus providing an allowance for path loss between the data terminals and the processing units. The terminal impedances of the dipulse paths are 600 ohms, resistive.

Fairly stringent tolerances are placed on these signals. The timing component has both the conventional long term stability requirement (expressed as a time between zero crossings), and also a short-term or cycle-to-cycle limit called "jitter." The data and start components are tied quite tightly to the timing through most of the bit interval by the instantaneous phase variation limit of $\pm 1\%$. The data processing units obtain information from these dipulses by interrogating only a few microseconds of the bit interval, usually at either peak of the dipulse. The accurate timing component plus the instantaneous phase tolerance insures the correct time position of this interrogation interval. With this technique, the waveshape at the beginning and end of the bit interval is of minor importance so that the tolerances have been relaxed at these points to allow reasonable transients. The permitted level variations come out to be about ± 1 db at the data circuit input and ± 1.5 db at its output. The allowable peak signal–peak noise ratios at these same two points are 30 and 20 db respectively.

It may be noted that the differences between the dipulse signals at the input of the data circuit and those at its output are minor; the transmission is substantially distortionless. The dipulses, however, are transmitted as such over only a small part of the total length of the data circuit, at most a few miles. In the transmitting data terminal (DDT), the dipulse information is modulated on a suitable carrier (2,000 cps). This modulated signal is transmitted over specially treated voice bandwidth facilities to the receiving data terminal (DDR), where the information is extracted and regenerated in the original dipulse form.

This regeneration technique is also applied to the timing component which is regenerated by a local oscillator in the DDR that is periodically synchronized on each start pulse. The method of deriving timing limits the time between start pulses inasmuch as the local oscillator stability must be such that it can free-run for this period accurately enough to meet the requirement of Fig. 2. A system of this kind is, therefore, limited in the message lengths that it can handle. The 1,300 bit data system is designed to handle message lengths up to about 300 bits. The 1,600 bit system is designed primarily for message lengths in the neighborhood of 60 bits.

Not all of these bits can be used to carry information. The two bits preceding the start pulse (end of one message) and the two bits following it (beginning of the next message), must be identical. In the SAGE system, for example, the start pulses are always preceded and followed by two spacing bits. It may be noted also that this timing scheme is not capable of reproducing wide timing variations. About the maximum variation it can follow is $\pm 0.01\%$, or ± 0.13 cycles in the 1,300 bit system and ± 0.16 cycles in the 1,600 bit system.

The SAGE data circuits are designed for continuous operation, that is, meaningful messages or blank message frames are on the line at all times. The circuits are not designed for, nor are they capable of, start–stop operation. Neither are they designed to take rapidly and widely varying message lengths. In the SAGE system the message lengths vary from about 60 to 300 bits depending on the circuit use, but the message length on any particular circuit remains fixed. It seems probable, however, that a given circuit could handle a moderate variation in message length although no performance tests have been made under these conditions. It may be noted here also that the same data terminal apparatus is not used for both the bit rates that have been discussed herein. Different versions of the *A1* Digital Data Signaling System are used for each speed.

DATA CIRCUIT LINE FACILITIES

IT WAS MENTIONED EARLIER that the sending and receiving data gear at the circuit terminals are interconnected by specially treated voice bandwidth facilities. It is now appropriate to describe briefly what this special treatment amounts to and how it affects the engineering of these line facilities.

Because of the extent of the SAGE system and the number of data circuits that it requires, it has seemed imperative from the beginning to avoid as much special treatment of the line facilities as possible. It has seemed equally imperative that the existing national network be used to the fullest extent practicable. This network comprises all types of line facilities, both voice frequency and carrier. Significant economic penalties would accrue if any very large slice of this network could not be used for SAGE data transmission. A given route, for example, may be developed for a certain type of carrier, and if this carrier cannot be used, another route must be found. To provide a limited network, this may well be possible and a considerable amount of this selection of facilities and routes is constantly done in the furnishing of special services. The larger the desired network, however, the less practical this process becomes and it seems entirely impractical for a network the size of that required for SAGE. These two factors, use of the national network and a minimum of special facility treatment have, in fact, been basic in the SAGE concept.

As used herein, the term "special treatment" includes measures over and above those normally involved in the provision of a circuit for standard voice message purposes. For the data circuits, this special treatment comes down to two main areas of activity. The first of these is the provision of delay equalization.

A standard message circuit will generally have significant differences in transmission time between various parts of the frequency spectrum. This is of little consequence for voice use but of considerable consequence for data, telephotography, and allied applications where the rate of information flow is much higher. This difference in transmission time, or delay, varies with the type of facility in question and in some types of facilities also varies with the circuit length. This distortion results in different frequency components of the signal arriving at

the receiving end of the circuit at different times, and unless it is corrected, a degradation of the signal results.

In order to alleviate the effects of this distortion, it is customary to use only the part of the available circuit bandwidth that can be readily equalized. The least distortion will be found in the middle range of the circuit bandwidth; it is much greater in the upper and lower circuit cutoff regions. In the SAGE data circuits, these cutoff regions are not used at all, the line signal energy of the *AI* data system being confined to the region from 1,000 to 2,600 cps. (The signal pass band has to be limited and shaped anyway for other reasons.) The delay distortion in this region is held to within ± 250 microseconds; in most cases, delay equalization has to be added to keep within this limit. The limit itself was set on the basis of telephotograph experience and theoretical consideration of the SAGE requirements.

Each type of line facility has an individual and distinctive delay distortion characteristic. It is possible, therefore, to predict the distortion characteristic for any data circuit providing its make-up (the types and lengths of line facilities comprising it), is known. Knowing the distortion characteristic, it is entirely practicable to apply the appropriate equalization to reduce it. Circuits can be equalized in this manner to a reasonable degree of precision if the circuit make-up information is accurate and if no impedance irregularities exist. This is the general method used to equalize the data circuits for SAGE; it is a prescription process rather than a measurement process. The technique also includes procedures designed to expose any impedance irregularities that may exist; this has been found to be essential. Not all circuits can be equalized with this method, some make-ups are so complex that an actual measurement must be made. Fortunately, this holds for only a small minority of the data circuits. In conclusion, it may be noted that the delay distortion characteristics of the circuits are fairly stable and, for the circuit lengths involved in SAGE, relatively little seasonal change may be expected.

The second major area of effort has been in the control of circuit noise. As pointed out earlier, SAGE data circuits work to some degree in real time and the emphasis has necessarily been on cutting down the incidence of errors rather than their correction. This, in the end, comes down to a problem of circuit noise.

It may be noted at the outset that the national network was, and is, still being built primarily for the transmission of information via the spoken word. Any added use of it, such as data transmission involves an adaptation process to reconcile conflicting technical requirements or to meet new ones. Although this may be a troublesome job, the economic advantages attendant on it make it well worthwhile.

The noise situation is a good example of this. The frequency response of the human ear is not flat but is peaked in the middle range of audible frequencies, around 1,000 cps. Above and below this, its response falls off, particularly so in the region below about 500 cps and above about 2,500 cps. This has been considered in the engineering and construction of the national network and its basic noise characteristics reflect this kind of a weighting. The net result of this is that any other user of the network that does not have this built-in weighting is likely to encounter comparatively high noise, particularly at the low end of the spectrum. Another human characteristic that is of interest in this regard is the response time or "time constant" of the ear. It has been found that noise meters with a time constant of 200 milliseconds (plus the appropriate weighting) give the most accurate gauge of the effect of circuit noise on normal voice transmission. Noise bursts of shorter duration than 200 milliseconds have correspondingly less effect and their effect continues to decrease as their duration time shortens. This, too, has been reflected in the engineering of the national network so that, in addition to their weighting, the circuit noise characteristic may show sporadic short-noise peaks that may range anywhere from 10 to 50 db above the average or steady-noise level.

The rate of occurrence of these noise bursts, called impulse type noise, as well as their peak factor will vary with the type of facility. Actually, it depends on the noise exposure; some types of facilities, particularly some types of carriers, work under more severe noise exposures than others because of their area of application in the telephone plant. The sources of this impulse noise are many and varied, the two main causes being atmospheric static disturbances and circuit switching operations.

So far as the SAGE data systems are concerned, the effect of both the network noise weighting and the average circuit noise level is not controlling. As noted, the signal spectrum is carefully shaped and limited anyway, so the *AI* system normally operates in the part of the circuit bandwidth where the noise is most carefully controlled. Furthermore, the weighted average noise level on any normal circuit is not likely to be such that it will impair the operation of the data system. The level of this noise is held to that acceptable to human beings and they are much less tolerant than the SAGE data systems in this respect.

Impulse noise is something else again. Just the opposite is true—the SAGE data systems are much less tolerant of this type of noise than human beings. The information carried by these systems is in digital form with the bit intervals less than a millisecond in length. The level of impulse noise of this or shorter duration intervals accordingly constitutes our main concern in the whole noise area. It has recently been determined that errors in transmission generally occur only when the magnitude of individual noise peaks exceeds about -15 dbm (decibels referred to a milliwatt) at the 0 dbm transmission level point. Plans now under preparation make necessary modifications in various techniques of circuit design and noise measurement to reflect this criterion. The design techniques vary with the facility involved; most of the work in this area concerns the shorter haul carrier systems because they operate at lower line levels than have heretofore been employed.

The accomplishments in both the noise and delay problem areas have borne fruit in making possible the

widespread use of the United States national network for SAGE data circuits. All the standard Bell System type of facilities except circuits with heavier loading than *H* or *B88*, and one older type of carrier, are being used for this purpose at present. These exceptions do not represent a significant part of the network.

One further point may be noted with respect to facilities. The choice of dipulse signals as the input and output signals of the data circuits eases the problem of connecting the data circuits and the data processing apparatus considerably. In most cases, separation of the data circuit terminals and the data processing apparatus has been found to be desirable and necessary. These dipulse signals permit this; they can be transmitted quite readily for several miles if necessary.

PERFORMANCE

THIS SUMMARY of the main features of the data circuits provided for the SAGE system would not be complete without a few words as to their performance. Only a limited number of circuits are presently in service but these results are also being supplemented by a rather extensive field testing program designed to check error performance. On the basis of this experience, it seems that the 1/100,000 blanket error rate, roughly 1 error per minute, is generally met if the errors are averaged over a fairly long period—at least several hours. The normal circuit performance is not a fairly constant incidence of errors from minute to minute but many minutes of absolutely error free transmission followed by a burst of errors—or errors equivalent to a burst—then error-free transmission again.

CONCLUSIONS

THE PROBLEM OF TRANSMITTING INFORMATION in real time seems likely to face us for some time to come. The SAGE system is only one example of it, many more applications presently exist or are in the planning stage. The material that has been presented herein represents one approach to this problem; other approaches are possible and are, in fact, being tried. It seems probable that the experience gained in this and other data systems will ultimately indicate the best technical and economic solution of the real-time data problem.

Trends in Railway Electrification

B. A. ROSS
ASSOCIATE MEMBER AIEE

A survey of world-wide trends in electric traction over the past decade shows the United States lagging in electrification projects and emphasizing the use of diesel power. More attention is urged for these projects in view of the greater abundance of hydroelectric power, coal, and possibly nuclear power as compared with oil.

THE PAST DECADE has been one of significant changes in methods of operation and motive power design on the electrified railways of the world. In every part of the world, with the exception of North America, notable electrification projects have been carried out. An indication of the extent of electrification programs in Europe and the Soviet Union is the more than 1,300 miles of continuous electrified operation extending from Paris to southern Italy, the 1,390 continuous miles from Narvik, Norway, to Tralleborg in southern Sweden, and the lengthy electrified section of the Trans-Siberian railroad in the USSR.

The most significant change in electrical operating procedure has been the widespread adoption of single-phase industrial frequency (50-cycle) power delivered at relatively high voltage (20 to 25 kv) for mainline electrification. The first electrification projects employing 50-cycle, single-phase current were carried out in the 1930's on the Hungarian line from Budapest to the Austrian frontier operating at 16 kv and the Germany Hoellenthal Railway operating at 20 kv. As a result of studies of these systems by French engineers, the French National Railways in 1950 electrified a 48-mile section of line between Aix-les-Bains and La-Roche-sur-Foron at 25 kv, single-phase, 50 cycles. The industrial supply was tapped by a single substation roughly midway in the section and

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converted from 42 kv to 25 kv by two 6,000 kva transformers.

The successful results of the initial 48-mile project caused the French National Railways to commence the 50-cycle, single-phase, 25-kv electrification of 188 miles of line from Valenciennes to Thionville in 1953. This line is one of the important freight lines in Europe, inasmuch as it is a principal route for coal and iron ore for steel mills in Belgium, northern France, and the Saar. Advantages of industrial frequency electrification over special low-frequency a-c or d-c electrification are the absence of stationary conversion equipment and the ability of the railway administration to use the national grid system. By using the relatively high distribution voltage of 25 kv, French engineers have been able to obtain a spacing of 50 to 70 miles between substations as compared with 5 to 7 miles on lines using the 1.5 kv d-c system previously standard on French electrified lines. As a result of the higher operating voltage, the catenary system and its supporting structure is much lighter and cheaper when compared to lower potential systems. The successful performance demonstrated by the French Valenciennes–Thionville Line has resulted in similar

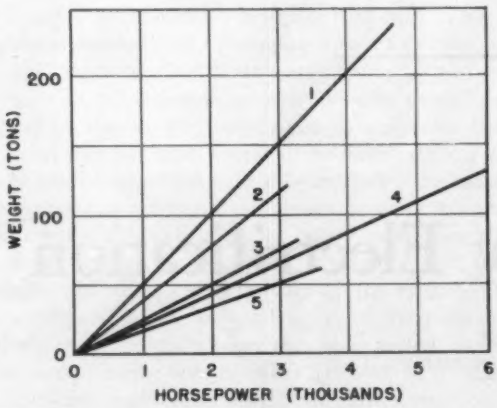


Fig. 1. Horsepower vs weight curves for representative electric locomotives.

projects being carried out in the Saar, Luxembourg, Great Britain, the Soviet Union, Japan, and the Belgian Congo, in addition to further extensions of 50-cycle electrification in France.

FUTURE PROJECTS

As a result of the rapid development of the industrial frequency single-phase traction mentioned, investigations and planning for future industrial frequency electrification projects have been carried out in many parts of the world. Two of the most interesting are the plans of the British Transport Commission in Great Britain and the investigations made by the Norfolk and Western Railway in the United States. In 1956, the British Transport Commission announced the decision to electrifiy the London to Liverpool and Manchester and the London to Leeds and York main lines of the British Railways, plus considerable branch and suburban mileage in the Midland, London, and Glasgow regions. This will represent a total of about 1,200 route miles of new 50-cycle electrification. The scheme will draw its power from the national grid at substations stationed at up to 40-mile intervals. The study of the Norfolk and Western between Williamson, W. V., and Roanoke, Va., carried out under sponsorship of the Association of American Railroads indicates extensive academic interest in this country and perhaps, at some time in the future, an industrial frequency program will be feasible on certain of the heavier traffic density United States lines.

In addition to the industrial frequency electrification projects mentioned, other large electrification schemes have been carried out in France, Great Britain, Austria, Belgium, Holland, Italy, USSR, South Africa, and New Zealand. The French 1.5-kv d-c electrification of the 317 miles of heavy traffic density line from Paris to Lyons is the biggest project since World War II, with the possible exception of Soviet electrification projects. As a result of this project, 231 electric locomotives were able to replace over 600 steam locomotives, and the average speed of the "Mistral," the fastest express, was increased to 79.3 mph for the 317 mile run from Paris to Lyons. The main British electrification scheme in recent years has been the 1.5-kv d-c electrification of the Manchester–Sheffield–Wath Line across the Pennines. In the Soviet Union electrification schemes have gone forward until, in 1954, the total electrified mileage was estimated at 4,500, mostly located in the Caucasus, the Urals, and Western Siberia. The standard voltage used on Soviet projects is 3,000 volts d-c. The world's longest continuous electrified line, the 1,460 mile line linking the Kuzbas coal fields with the Ural industrial complex via the western section of the Trans-Siberian Railway, was completed in the 1946-50 period. Only in the Western Hemisphere has electrification lagged; in North America not only has there been no extension of electrified lines, but two major lines, the Norfolk and Western, and the Great Northern, have discontinued existing electrified lines.

In considering electric railway locomotives, it should always be remembered that the electric locomotive is primarily a converter of energy rather than a self-contained power plant as are diesel electric, gas turbine, and steam locomotives. In d-c locomotives, the inherent advantages of the d-c traction motor present the locomotive designer with little choice as to basic electrical arrangement other than refinement and improvement of existing components. In single-phase a-c operation, the designer is presented with four possible methods of energy conversion, all of which have been proved by successful operation: (1) the locomotive may be equipped with single-phase a-c motors operating on system frequency, (2) a motor generator on the locomotive may be employed to convert the a-c to d-c for traction motor use, (3) some type of rectifier may be employed to convert to d-c for traction motor use, and (4) the single-phase a-c

may be converted to 3-phase a-c for use by 3-phase a-c traction motors.

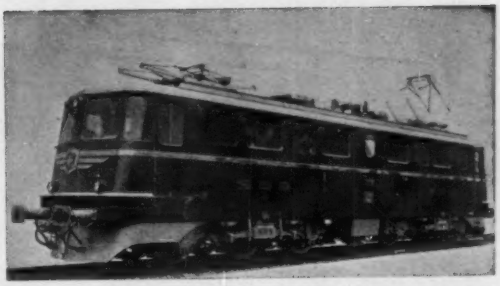
RECTIFIER LOCOMOTIVES POPULAR

MOST A-C LOCOMOTIVES in use today utilize system No. I in the foregoing listing. A considerable number of machines have been constructed in recent years employing systems No. 1 and 2. The future of rectifier locomotives appears quite bright and they may be expected to appear in increasing numbers. Proof of the efficiency of rectifier units is their demonstration as the most effective means of using an industrial frequency supply for traction in France and the decision of the British Transport Commission to use rectifier equipment in all motive power procured for their new electrification program (System No. 3. System No. 4 is utilized only by the 50-cycle locomotives of the Hungarian State Railways and, with the exception of Westinghouse machines built some 30 years ago for the Norfolk and Western, and Virginia Railways, has not been adopted by any other railway administration. Improvements in conversion equipment for the a-c systems mentioned have made a-c electrification increasingly attractive in recent years. Since World War II, refinements in motor generator design and the introduction of improved mercury arc rectifiers have permitted the use of smaller and lighter units for locomotive mounted conversion equipment.

The use of ignition rectifiers to convert a-c to d-c for traction motor use has been a feature of several recent electric locomotives constructed in both the United States and Europe. Examples of recent mercury arc rectifier locomotives are the 10 General Electric (GE) locomotives constructed in 1955 for the New Haven Railroad passenger service, the Class *E-3b* locomotives built by Westinghouse in 1951 for the Pennsylvania Railroad, 12 GE 3,300-hp locomotives built in 1956-57 for hauling coal trains on the Virginian, and a 3,260-hp locomotive built for the French Valenciennes–Thionville electrification scheme. Still another method for converting a-c to d-c for traction motors is the use of germanium rectifiers which after undergoing operational tests in England on electric motor coaches used on the Lancaster–Morecambe–Heysham 50-cycle electrification scheme has been selected as the conversion equipment for 35 motor coaches to be purchased by the British Railways.

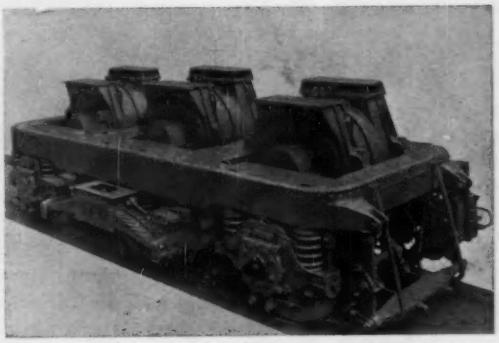
RUNNING GEAR ARRANGEMENTS

THREE BASIC runing gear arrangements are employed on electric locomotives; the first of these is, with the driving axles and motors, a fixed part of the locomotive's main frame. The rigidly mounted driving axles may employ either an individual drive where each axle is driven by a motor, or motors, or a collective drive where the motor or motors drive several axles through the use of connecting rods. Considerable numbers of locomotives employing frame-mounted driving axles with individual drive have been built in Europe in recent years. The only recent locomotives employing the collective drive with connecting rods are the Class *DM* 5,000-hp, two unit, $1-D+D-1$ freight locomotives of the Swedish State Railways. The second arrangement of running gear is the use of an articulated running gear in which the drawbar pull is transmitted by use of a pin or articulated coupling. This is the type of gear employed on the familiar *GG-1* locomotives of the Pennsylvania Railroad and many other modern locomotives. Locomotives employing an articulated running gear



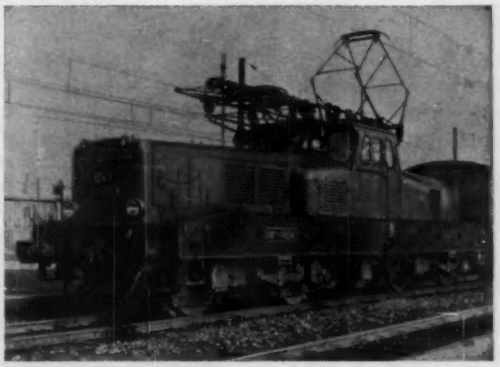
Courtesy Swiss Locomotive and Machine Works

Fig. 2. Co Co type, 6,000 hp electric locomotive, series Ae 6/6, of the Swiss Federal Railways, for 16⅔ cycle, 15 kv a-c, using single-phase a-c motors.



Courtesy Swiss Locomotive and Machine Works

Fig. 3. Three-axle motor truck of special SLM design mounting three 1,000 hp, 14-pole single-phase, a-c motors, used with Ae 6/6 locomotive.



Courtesy Societe des Forges et Ateliers du Creusot

Fig. 4. Bo Bo type, 3,260 hp ignitron rectifier locomotive, of the French National Railways, for 25-kv, 50 cps a-c.

Courtesy Alsthom

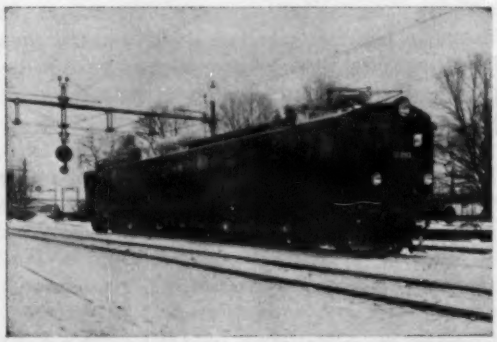
Fig. 5. Co Co type, 5,000 hp d-c locomotive of the French National Railways, for 1.5 kv d-c operation. Same class as the holder of the world speed record of 206 mph.

have, in the past few years, been constructed for use in England, South Africa, and New Zealand. The last and, in recent years, most popular type of wheel arrangement is the use of trucks with motors mounted on their frames. This arrangement, similar to that of United States diesel electric, uses the locomotive body frame to transmit the drawbar pull. Locomotives using trucks with integral motors have been constructed in large numbers since World War II for operation in almost every country employing electrified railways.

DESIGN TREND

THE TREND in electric locomotive design, in recent years, has been to high horsepower lightweight units, as illustrated in Fig. 1. As an indication of the progress made, the Swiss Federal Railways' 122.5-ton *Ae 6* locomotives built in 1952 and mounted on two 6-wheel power trucks have a 6,000-hp one-hour rating compared with a 3,120-hp one-hour rating for the 123.3 ton *Ae 4/7* locomotive, the standard electric locomotive of the Swiss Federal Railway in 1934. These improvements in horsepower to weight ratio have been possible because of progress in the design of smaller, more powerful motors and improvements in truck design, permitting better riding characteristics at high speeds. It is of interest that the French electric locomotive holding the world railway speed record of 205.5 mph employed a powered truck type of running gear (two 2-axle units). When comparing horsepower to weight ratio, it is well to remember that the much heavier United States trains, expresses of 1,000 to 1,500 tons compared to about 600 tons in Europe, tend to favor a heavier machine to utilize the available motor horsepower better without excess slippage.

Weight reductions similar to those made in running gear and traction motors have been made in protective equipment, control gear, and auxiliary equipment weights. Recent trends in equipment of this type include the use of high tension control for tap changers, thus reducing the magnitude of current that must be broken,



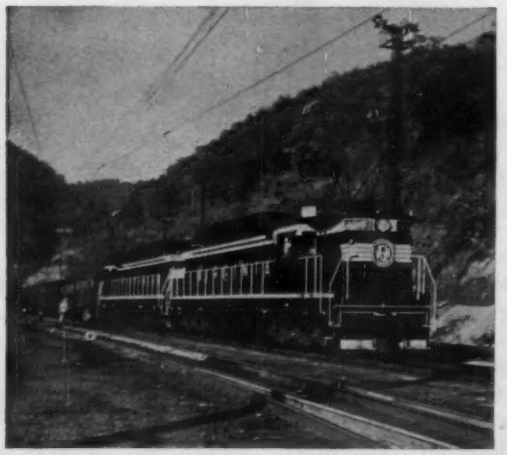
Courtesy Aktiebolaget Motala Verkstad

Fig. 7. Class *DM* 1-*D*-*D*-1 locomotive, equipped with collective drive, used by the Swedish and Norwegian State Railways in freight service.

the replacement of oil circuit breakers by air blast circuit breakers, and the use of lighter more efficient control systems. The use of strip-metal resistances in place of cast-iron resistors has permitted a reduction in the weight and bulk of the control system on recent d-c locomotives.

Again, as in new mileage, North American new electric locomotive production in numbers of new units produced has lagged far behind the rest of the world in the past decade.

In the United States, because of the lack of recent schemes and emphasis on diesel usage of our railways, we may tend to overlook or fail to consider the advantages of electric traction. However, it should be remembered that where hydroelectric power, coal, and, possibly in the future, nuclear power are abundant compared with oil, electric traction in view of recent advances in distribution systems and locomotive design should receive serious consideration as a solution to railway operating problems.



Courtesy General Electric Company

Fig. 6. Ignitron rectifier freight locomotive of the Virginian Railways, 3,300 hp, for 11 kv, 25-cycle, a-c service.

Evolution of Large Thrust Bearing Design

R. A. BAUDRY
MEMBER AIEE

VERTICAL WATER WHEEL generator units have been made possible, to a large extent, by the development of efficient and reliable thrust bearings.

The first pivoted pad thrust bearings installed in 1912 are approaching half a century of continuous service. They are still operating as efficiently and reliably as when they were installed.

With the development of large power stations, with machines of large ratings, and the use of Kaplan-type turbines having large hydraulic thrust, thrust bearings of increased capacity and size became necessary and were developed as the result of field experience supplemented by laboratory tests.

New manufacturing facilities, including precision boring mills installed in air-conditioned rooms, the use of instruments for measuring surface roughness, and optical straightedges such as the one shown in Fig. 1, make it now possible to manufacture economically the large thrust bearing runners now required with consistent, high standard of quality.

As a result of laboratory tests and investigations, all large thrust bearings now have runners made of hard alloyed forged steel and use a larger number of pads. It was also found that the use of heavy thrust blocks either removable or integrally forged with the shaft was very beneficial. Many of these new type bearings employing large thrust blocks and runners have been in service more than 10 years without the slightest indication of fretting corrosion or any other difficulty, substantiating the adequacy of the new design.

The load and thermal distortion of the pads is of equal importance during the starting period and during normal operation. The design of the pad and its support is a compromise between many contradictory conditions and is such that the maximum unit loading while starting and the maximum distortion during normal operation will be within desired values. A support of the type shown in Fig. 2 in which equalizing levers can be proportioned to obtain the desired loading condition has been found more suitable for large thrust bearings.

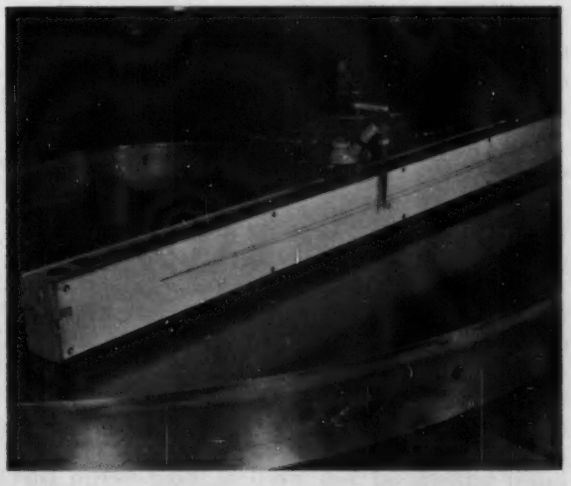


Fig. 1. Optical straightedge which can measure deviation from a plane surface of 40 microinches in 40 inches. The line on the graph paper indicates that this runner has a dish of 0.0004 inch.

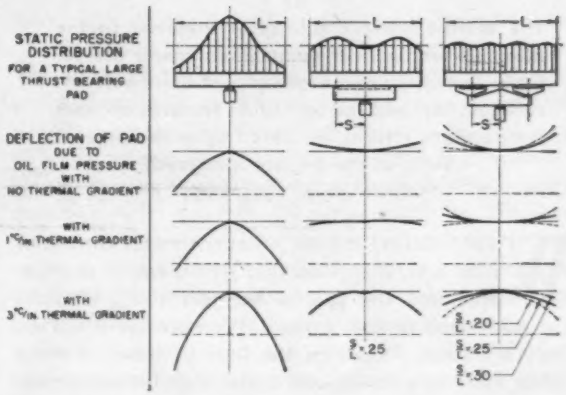

STATIC PRESSURE DISTRIBUTION FOR A TYPICAL LARGE THRUST BEARING PAD
DEFLECTION OF PAD DUE TO OIL FILM PRESSURE WITH NO THERMAL GRADIENT
WITH 1°C/in. THERMAL GRADIENT
WITH 3°C/in. THERMAL GRADIENT
L
S
S/L = .25
S/L = .20
S/L = .25
S/L = .30

Fig. 2. Unit loading on surface of pad and deflection of pad with various types of supports.

As the speed or size of the bearing increases, special seals and oil deflectors must be provided to prevent oil leakage or turbulence which could interfere with the adequate lubrication of the bearing. On medium- or high-speed machines there is an appreciable amount of aeration of the oil, which produces excessive foam and may interfere with the lubrication of the bearing.

As a result of laboratory tests with transparent oil guards and glass runners, it has been possible to develop inner and outer seals in which turbulence of the oil and the resulting aeration have been entirely eliminated.

In recent years, the practice of establishing an oil film before starting has been introduced on a number of thrust bearings. With this practice it is necessary to keep the oil exceptionally clean.

A knowledge of the fundamental characteristics of the bearing surfaces makes it possible to establish operating procedures which, with a minimum of preventive maintenance, insure years of trouble-free service.

Digest of paper 58-171, "Evolution of the Design and Operation of Large Thrust Bearings," recommended by the AIEE Rotating Machinery Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 2-7, 1958. Published in AIEE *Power Apparatus and Systems*, Aug. 1958.

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Thermoelectric Heat Pumping

N. E. LINDENBLAD

The thermodynamic principles involved in the area governing heat pump phenomena are set forth. The utility and economics of thermoelectric refrigeration and the reversible features of room temperature control, as based upon the present state of the art, are analyzed.

WHEN OTHER FORMS of energy are converted into heat, it appears that all the energy is available and the process becomes 100% efficient. For conversion in the opposite direction this is not so. Only a certain portion of the heat in transit from a hotter body to a cooler one is available for conversion into other forms of energy, but in ideal circumstances all of this heat in transit can be made to flow back to its original state by this same portion of energy of other form which it had created. Heat is the equivalent of the communicable portion of the random molecular and submolecular kinetic energy in matter and is proportional to the absolute temperature.

If heat from a hotter body is communicated to a less hot body without doing any work, the total heat quantity, now reduced to a lower temperature, remains unchanged. All the energy potentially available before the transfer has become unavailable. If, on the other hand, the maximum of work which can be performed by the heat in transit is extracted, by means of a suitable device, the total quantity of heat is reduced proportionally to the absolute temperature drop of the system. The difference between the total end quantities of heat obtained in the two different types of heat transfer thus represents the available energy which was converted into work. This difference divided by the original heat quantity then represents the efficiency of the transfer.

Calculations can now be performed to show that when the end quantity of heat transferred decreases less than in proportion to the absolute temperature, the efficiency is lower. If, on the other hand, the heat transferred would be reduced more than in proportion to the absolute temperature, then letting the extracted work energy operate in reverse, the temperature of the original source could be exceeded and a "perpetuum mobile" of the second kind could be realized. The energy extracted on the heat–temperature proportionality basis is thus a maximum, and the efficiency so obtained is a maximum and the entropy of the system remains unchanged. This is the Carnot efficiency of reversible energy conversion between available heat and other forms of energy; it is dependent only upon the temperature difference between the heat source and the heat sink and the temperature of the source, measured in absolute units.

In all practical processes, it is, of course, natural that such efficiencies are never realized since any actual operation will always be accompanied by irretrievable losses which result in an increase of the unavailable energy at the expense of the available energy.

The efficiency of the ideal converter of heat into other forms of energy can thus be written:

$$\eta = \frac{T_1 - T_2}{T_1}$$

but since this is not attainable in practice due to losses, the efficiency must be multiplied by a factor of merit which will be governed by the particular characteristics of each particular device. Thus

$$\eta = \frac{T_1 - T_2}{T_1} M_e$$

REVERSED PROCESS

IN THE CASE of the reversed process when other forms of energy are used to move heat, as in heat pumps, it is less confusing to speak of coefficient of performance than to speak of efficiency in the ordinary sense. Thus, the expression for the ideal heat pump would be

$$\text{cp} = \frac{T_2}{T_1 - T_2}$$

but since heat pumping also will be accompanied by irretrievable losses, the expression for the practical case will be

$$\text{cp} = \frac{T_2}{T_1 - T_2} M_p$$

In thermoelectric devices, the irretrievable losses derive from electrical resistance and heat leakage.

Seebeck discovered, over a hundred years ago, that if the junctions at opposite ends of a closed circuit loop consisting of two branches of dissimilar conductors were maintained at different temperatures, an electric current was generated in the loop. Peltier reversed the phenomenon and found that by introducing a current in the loop a temperature difference could be established between the two junctions. Lord Kelvin later gave mathematical formulation and thermodynamic interpretation to these phenomena on a classical basis.

A special article recommended by the AIEE Solid-State Devices Committee and the Electric Space Heating and Heat Pumps Subcommittee (East) of the AIEE Domestic and Commercial Applications Committee.

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Altenkirch still later formulated the problem to indicate more clearly the characteristic requirements in junction materials intended for heat pumping, but found those characteristics unattainable at that time.

THERMOELECTRIC MATERIALS

PROGRESSIVELY BETTER UNDERSTANDING of the atomic mechanisms in solids has advanced the art of composing substances for various purposes by providing the proper atomic conditions favoring the enhancement of particular characteristics for specific functions. It has, for instance, in the area of thermoelectrics, become possible to provide thermoelectric materials having sufficiently effective characteristics to make them contenders for practical application in the growing need for reversible, simple, and direct conversion or exchange media between electrical and thermal energies.

Basically, an effective thermoelectric material is characterized by a high quotient between the squared value of the thermoelectric power and the electric resistance and heat conductivity product. A high thermoelectric power can perhaps be most simply stated to mean that the electric current in the two thermocouple branches is carried by electrons of greatly differing energy. The difference in electron energy is either absorbed or liberated as heat at the junction boundary by interchange of kinetic energy with the atomic lattice. Thus, the lattice vibratory energy, which represents heat, can be depleted or added to, as the case may be. In most metals, the average energy of the electrons carrying the current is nearly the same, but can be modified to a certain extent by alloying. As a rule, however, the thermoelectric power obtainable from metallic thermojunctions is of considerably smaller order than that obtained from semiconductors and their alloys. In greater detail, atomic mechanism, as revealed through theoretical development, does not permit the existence of more than one electron of a particular energy level to exist within the confines of a crystal lattice cell of a substance. For this reason, electrons must distribute over a great number of energy levels or bands.

Because of further wave mechanical consequences deriving from the periodic field distribution of the lattice, certain electron energies are ruled out in particular materials and cannot be occupied. Only electrons having sufficient energy can cross this gap into the conduction band. If the gap is moderate, we have a semiconductor and, if the gap is great, we have an insulator. The forbidden band then furnishes the condition which contributes to the one-way energy exchange and which makes the semiconductors the most fruitful area in which to search for substances having high thermoelectric power. It can now be understood that various materials will optimize in performance at different temperature levels or have various other limiting features, so that although the thermoelectric phenomena are reversible, it does not necessarily follow that one material can be universally used to best advantage.

We are here concerned with materials which optimize for heat pumping at temperatures with relatively nominal deviations from conventional ambient temperature levels. A now most widely recognized basic alloy in this category is bismuth telluride, either alone or with small quantity doping, or in combination with selenides of bismuth or selenides and tellurides of antimony. Lead selenides and tellurides can also be brought to satisfactory performance alone or in combination with the V–VI column elements already mentioned. Such combinations as zinc antimonide and zinc–cadmium antimonide may be mentioned as relatively good alternatives. Practically all of these combinations melt at about 600 C and lack permanence at temperatures considerably below this value. It appears that with a variety of adjunctive preparations, solders of the tin or lead alloy category offer workable and efficient means of making good contacts with these materials.

In the case of heat pumping, the coefficient of performance thrives on small temperature differences. In the case of thermoelectric generators, on the other hand,

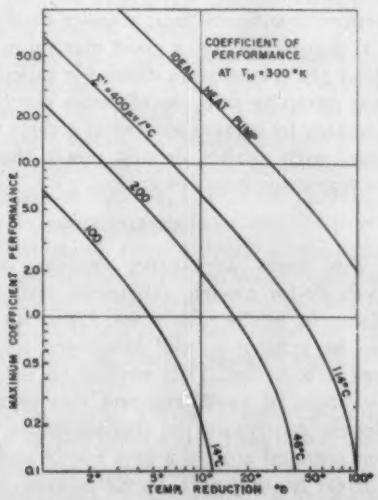

Fig. 1. Maximum temperature drop vs effective thermoelectric power.

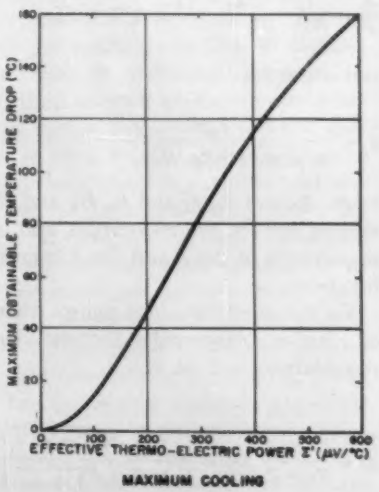

Fig. 2. Coefficient of performance vs load condition for various values of effective thermoelectric power.

high efficiency can be attempted only at large temperature differences.

It has been shown that the real efficiency of devices involving exchanges between thermal and other forms of energy may perhaps be most lucidly represented as the product of the ideal thermodynamic efficiency and a merit factor which includes the features, peculiar to a particular device, which detract from the attainment of the ideal efficiency.

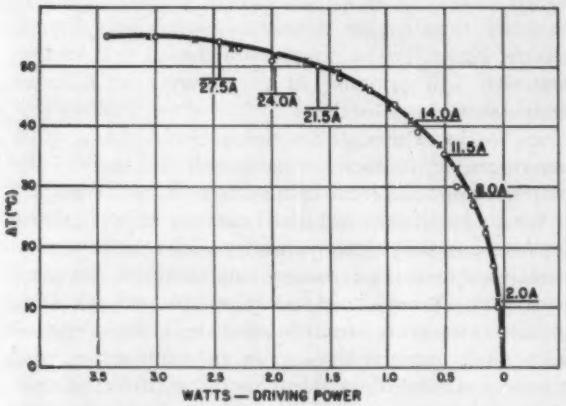

Fig. 3. Temperature differential vs driving power of unloaded heat-pump junction. (Test couple in vacuum hot junction, 27 C.)

For thermoelectric generators, the actual efficiency will then be

$$\eta = \frac{T_1 - T_2}{T_1} \times M_G = \frac{T_1 - T_2}{T_1} \times \frac{m_g - 1}{m_g + \frac{T_2}{T_1}} = \frac{T_1 - T_2}{T_1} \times \frac{\frac{R}{r} - 1}{\frac{R}{r} + \frac{T_2}{T_1}}$$

where R and r represent the external and internal resistance respectively and where this ratio is determined as follows

$$\frac{R}{r} = \sqrt{1 + Z\frac{T_1 + T_2}{2}} = \sqrt{1 + Z\overline{T}}$$

and where

$$Z = \frac{(\mathcal{E}_1 + \mathcal{E}_2)^2}{(\sqrt{\rho_1 H_1} + \sqrt{\rho_2 H_2})^2}$$

where $\mathcal{E}_1$ and $\mathcal{E}_2$, ρ_1 and ρ_2, H_1 and H_2 are the thermoelectric powers, the resistivities, and heat conductivities respectively of the p and the n branches of the thermojunctions.

For thermoelectric heat pumps where the effectiveness of a device is expressed as the coefficient of performance, the relations will be

$$cp = \frac{T_2}{T_1 - T_2} M_p = \frac{T_2}{T_1 - T_2} \frac{\sqrt{1 + m_p} - \frac{T_1}{T_2}}{\sqrt{1 + m_p} + 1}$$

where

$$m_p = Z\frac{T_1 + T_2}{2}$$

The maximum temperature difference which can be developed by a thermoelectric heat pump can be simply obtained by using the value of Z:

$$\frac{T_H}{\Theta} = \sqrt{1 + Z \times \overline{T}}$$

where T_H and $\overline{T}$ are the temperatures of the hot junction and the average temperature, respectively, and where Θ is the maximum temperature differential.

A calculation for finding the maximum obtainable temperature difference with a sample pair of n and p type bismuth and bismuth–antimony tellurides is herewith shown for the purpose of orientation:

$\mathcal{E}_1 = 190$ microvolts $\qquad \mathcal{E}_2 = 170$ microvolts

$\rho_1 = 8 \times 10^{-4}$ ohm-cm $\qquad \rho_2 = 10 \times 10^{-4}$ ohm-cm

$H_1 = 0.02$ watt/cm/degree $\qquad H_2 = 0.02$ watt/cm/degree

$$Z = \frac{360^2 \times 10^{-12}}{(\sqrt{1.6 \times 10^{-5}} + \sqrt{2 \times 10^{-5}})^2} = 1.81 \times 10^{-3}$$

$$\frac{T_H}{\Theta} = \sqrt{1 + 1.81 \times 10^{-3} \times (\sim 273)} = 1.223$$

$$T_H - \Theta = 300 - 245 = 55 \text{ C}$$

In order to appreciate the importance of good contact bonding, consider a number of successively smaller slugs made from identical thermoelectric material and proportioned to have the same electrical and thermal conductances. If the contact bonding resistance could be made equal to zero, or negligible, the heat pumping capacity of a slug would remain unchanged even when reduced to very small size. The extent of reduction of slug volume primarily is determined by the smallest permissible cross-sectional area which can still provide a low-contact bond resistance which is low compared with the internal resistance of the slug and also to conform with sufficient heat transfer conditions.

If a material has a good maximum cooling margin above the temperature difference called for in a certain heat pumping task, the efficiency can be increased considerably by using a somewhat greater number of junctions, with smaller driving power than that required for maximum heat absorption.

APPLICATIONS

THE CHIEF ATTRACTIVE FEATURE of thermoelectric methods for electric generators and heat pumps lies, of course, in the simple and direct ways in which they can be applied to and integrated with the operating area in a device. They require no moving parts and a minimum of auxiliaries and maintenance. In thermoelectric generators, the thermoelectric elements can be concentrated around a heat source such as a flame or a nuclear heating unit. In ice making, the elements can

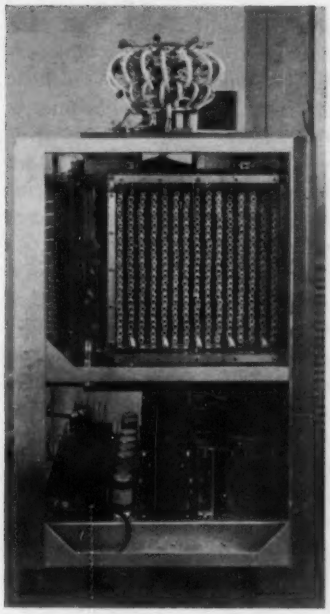

Fig. 4. View showing internal arrangement of water-cooled thermoelectric refrigerator.

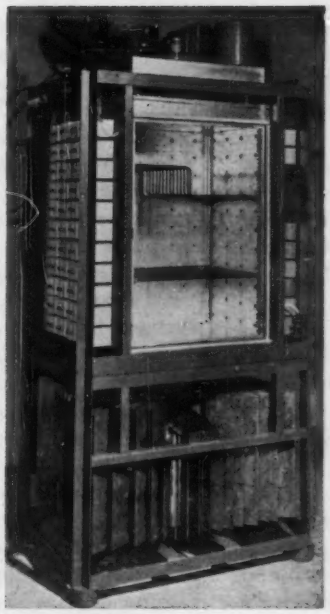

Fig. 5. Front view of internal arrangement of air-cooled thermoelectric refrigerator.

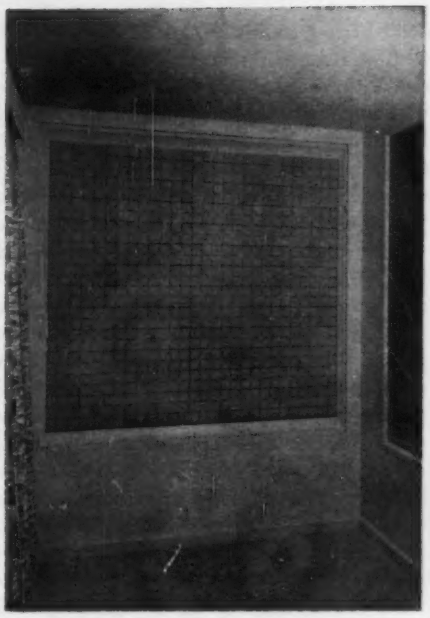

Fig. 6. Demonstration example of air convection type thermoelectric heat-pumping panels for room temperature control, inside view.

be concentrated around a freezing compartment. In the case of large heat-exchange areas, as in the case of refrigerator cool storage compartments and in reversible heat pumping panels for room temperature control, it often may be advantageous to scatter individual thermoelectric junctions or clusters of such junctions throughout the panel area. The design decisions are here governed by the best compromise which may be made to insure good heat insulation of the spaces between the active heat-pumping elements.

One of the design tasks common to all applications of thermoelectrics is the provision of proper heat-exchange terminals for the absorption and dissipation of heat into and out of the system. A simple approach is to provide a metallic tie between the junction elements and the exchange areas. Such areas, of course, can have many forms, depending upon the method of exchange —by contact to intermediates, by direct free convection exchange with fins, or by liquids, etc. It must be observed generally that because thermoelectric junctions have very low electrical resistance, it is preferable to connect large numbers of these in series. Consequently, proper arrangements have to be made so that the junctions are not all shunted by some common metal component in the system. If attachment to some common metal body becomes part of the design requirements, it will be necessary to provide a coupling sandwich with a thin intermediate layer of heat-conductive but electrically insulating material.

A thermoelectric junction is most effective if it is made up of a pair of two different thermoelectric materials in which heat energy is transferred in the direction of the electric current in one member and in the opposite direction in the other member. In this way, passive electrical return connectors, which would add to the heat leakage without contributing to the electromotive power in generators or to the heat transfer in heat pumps, are avoided. This necessary requirement has called for the development of both *p*-type (positive) and *n*-type (negative) thermoelectric materials. The atomic-electronic mechanism is quite different in these materials in that one operates on the basis of a deficiency of electrons free to carry current which, therefore, is instead carried by these vacancies or "holes," whereas the other carries current caused by abundance of free electrons.

Thermoelectric junctions have one particular virtue in that they provide their own best enclosure of a heat source. For example, consider a refrigerator compartment. If all its walls are made up entirely of thermoelectric junctions in which the individual junction elements have cross sections of such geometric configuration (e.g., triangular, square, hexagonal, etc.) that they can be put together to form mosaics, there will be no need for any conventional wall insulation. All the walls are effective heat pumps and the enclosure is not subject to any heat leakage except the backflow of heat in the junctions themselves. Inasmuch as internal resistance losses in thermoelectric heat-pumping junctions are proportional to the square of the electric current and the Peltier pumping is linearly proportional to the current, it follows that the driving power for these junctions can be reduced without comparably reducing the heat absorption at the cool end. Thus, significant efficiency gains can be realized.

Because the heat load on an enclosure like the one

described is small, it can be seen that, for junctions with a reasonable margin of maximum performance above the needed operational temperature differential, very materially reduced driving power will be needed. The number of junctions, therefore, can be determined, depending upon the thermal load anticipated in use which, in turn, will determine the parameters of the junction elements in tailoring them to cover the entire enclosure area. The need for effective disposal of the heat pumped through the cabinet walls then becomes a matter of providing effective heat exchange between the outside walls and the surrounding ambient atmosphere. This must be done with a minimum of temperature drop between the hot-junction terminals and the ambient, or the cool-junction temperature will rise an undue amount. The flat outer area of a cabinet is usually inadequate for this task and the heat exchange area will need to be increased by resorting to fin structures. The design described is a most efficient one but, presently at least, has to be subjected to previously mentioned compromises, chiefly on economic grounds.

As can be understood, the use of junctions for forming the total enclosure area of a cooling space does not go too well hand in hand with the idea of miniaturization and the application of junctions aggregated in units or modules which are more suited to spaced or scattered distribution over a cooling area. However, the same efficiency for the same temperature performance can be approached if provisions are made for a free, low-gradient flow of heat to and from the distributed junction points and for good insulation against leakage from the areas between the junction points.

ROOM COOLING

THE NECESSITY for the greatest deviation from the principle of a closely packed total enclosure of a space by means of thermojunctions becomes, of course, especially eminent in the case of room cooling. It is possible to visualize large and appropriately camouflaged or artistically executed cooling panels representing a relatively large percentage of the total enclosure area of a room, thereby reducing the required drop in temperature of the panel below that of the desired ambient. However, the real saving feature, in this case, is that smaller temperature differences are pursued in room cooling than in refrigeration. Experimental room cooling and heating by reversible heat pumping panels have indicated relatively good operating economy. The comfort from cooling panels (which, pending their design, may not entirely exchange their heat by convection but which partially provide radiant cooling and heating) is a very noticeable effect.

Considerable thought must be given to the proportioning of the heat exchange areas for thermoelectric heat pumping panels for room temperature control. Obviously, the basic requirement will be that the heat exchange areas on both sides of a panel should be as large as possible so that the ratio of the temperature differential across the junction elements to that between the inside and the outside ambients can be kept at a minimum. In this way, the ratio of the heat flow external of the junctions to the internal backflow of heat will be increased. On the inward side, a large fin system may possibly fail to conform to decorating principles. Also, while more efficient, because heat can be exchanged at lesser differences with the ambient temperature, the importance of the radiant effect becomes insignificant compared with the convection effect.

The heat exchange area for the outward side of a panel should normally be large. However, if a panel is used for heating purposes, it should be remembered that when the outside temperature differs more from the desired inside temperature than that which can be provided by the heat-pumping capacity of the panel, the heat gain above that from the supplied driving power changes to a loss. Then it becomes advantageous to isolate the outside heat exchange area and let the system operate instead as an electric heater.

Whether the panels are to be of the wall type or to be part of the ceiling, it becomes an architectural task to provide the proper communication between the panels and the outside air. In the case of an inside wall, a double wall with a spacing of about 6 inches will have to be provided. This space must be connected properly with the outside by means of ducts.

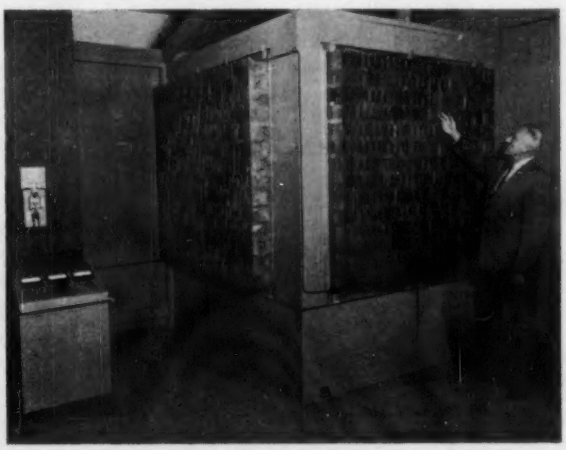

Fig. 7. Rear view of heat-pumping panel.

Sweating of the panels may or may not be endured pending purpose or other circumstances. The sweating can be prevented by a separate thermoelectric dehumidifier.

All thermoelectric heat pumps must be operated with direct current. It has been shown that very little drop of efficiency is caused by ripples up to 10 per cent. With such specifications, the cost of rectifier equipment can be kept low. In many cases it is possible to combine the junctions so that the a-c line voltage need not be altered by transformers. In the case of 3-phase supply, no smoothing need be applied to keep the ripple below the maximum permissible value.

Arc Recovery Strength Measurements

J. D. COBINE E. E. BURGER G. A. FARRALL
MEMBER AIEE

A SYSTEM has been developed for determining the recovery strength of arcs by means of a sine-wave source of current and a high-voltage pulse. Arcs can be studied at currents up to 8,000 amperes, and recovery voltages to 37 kv. The system is shown schematically in Fig. 1. In this figure, the 60-cycle arc-current circuit is designated by the heavy line. The arc under study is drawn in Switch I. The high-voltage pulse that is used to "probe" the residual plasma of the arc is applied between Switch I and Switch II. Switch II is used to isolate the high-voltage pulse from the low-voltage power source. The sequence of operation of the two switches is shown by the simulated current oscillogram of trace A of Fig. 2. Since Switch II is opened near the zero of the current wave, it is deionized much more rapidly than the switch under test and is therefore able to withstand much more voltage than that at which Switch I re-ignites.

Trigger pulses developed for activating the various elements of the system are shown by traces B, C, and D of Fig. 2. The instant of current zero is determined by a peaking transformer the output of which is shown by trace B of Fig. 2. The high voltage pulse can be delayed

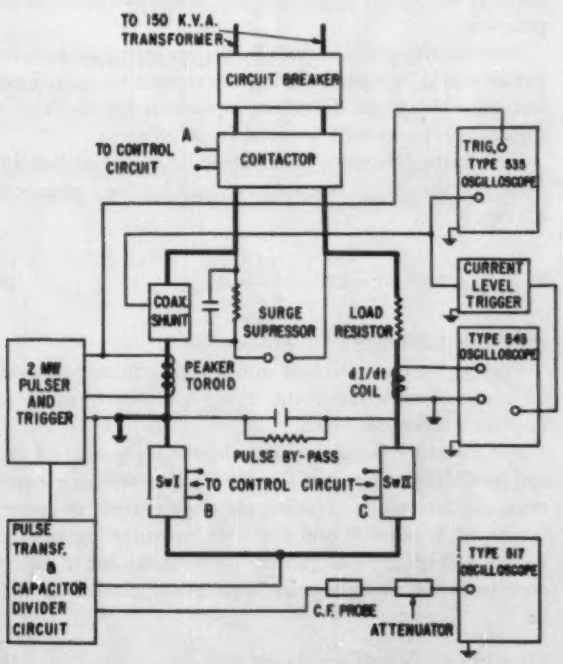

Fig. 1. Block diagram of impulse recovery system.

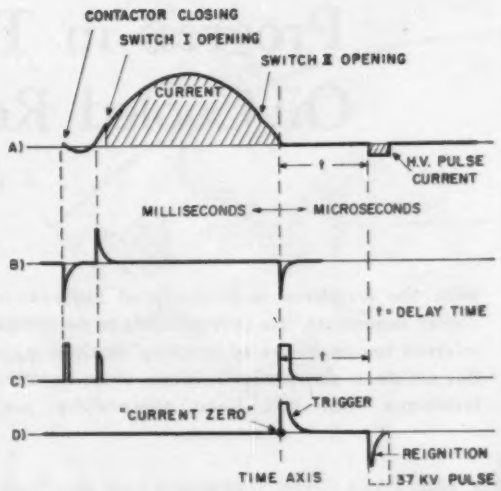

Fig. 2. Simulated oscillogram of current and impulses—A. arc and pulse currents, B. output of peaker, C. shaped trigger pulses, D. delay trigger and high voltage pulse (dotted = no breakdown, solid line = breakdown).

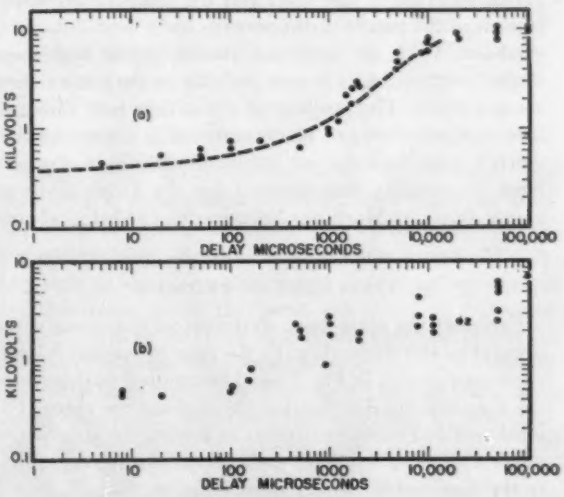

Fig. 3. Recovery strength of nitrogen arc—(a) 20 amperes, Kelham mean curve; (b) 400 amperes, copper electrodes, 1-inch diameter, 3/32-inch (2.38 mm) gap.

from 1 microsecond to 100,000 microseconds after the current zero trigger, as shown by the time interval t of Fig. 2. It was found that the exact instant of current zero may be determined only by oscillograms of the time derivative of the current.

Experimental data for the nitrogen arc at 20 amperes and at 400 amperes are shown in Fig. 3. The mean curve of W. O. Kelham for substantially the same physical condition is shown for comparison.

Digest of paper 58-902, "Impulse System for Arc Recovery Strength Measurements," recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

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Progress in Thermal Design of Oil-Cooled Rotating Machinery

P. B. RICHARDS

With the increased availability of high-speed digital computers, it is now possible to determine internal temperatures of rotating machinery. In this article, a description is given of an iteration technique that has been successfully programmed.

IN THE PAST electrical designers have been hindered by the fact that internal temperatures in a machine were not known with sufficient accuracy. At best, they had to be content with average temperatures estimated from measured coil resistances, for example, but the actual location of hot spots and the temperature distribution in the machine components have been difficult to establish. With the increased availability of high-speed digital computers, it is now possible to determine these temperatures. The purpose of this article is to illustrate how temperatures can be determined in components of electric machines by an iteration technique that has been successfully programmed for the IBM (International Business Machines Corporation) *650* digital computer.

STATEMENT OF PROBLEM

CONSIDER the plane cross section of an alternator rotor, normal to the shaft (Fig. 1). Because of symmetry, only the sector shown in Fig. 2 need be studied to determine the temperature distribution throughout the rotor. The mathematical problem consists in solving the steady-state heat conduction equation throughout this sector, subject to the specified boundary conditions. In the coil, heat is being generated, so the equation to be solved there is Poisson's equation

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{Q}{K} = 0 \tag{1}$$

Laplace's equation is valid in the rest of the sector:

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0 \tag{2}$$

No heat can flow across the radial lines, which are lines of thermal symmetry, so the heat that is generated in the coil will leave the sector through the circumferential lines. Mathematically, the boundary conditions are:

1. $\dfrac{\partial T}{\partial n} = 0$ at the straight boundaries (n = co-ordinate direction normal to the boundary)

2. $-K \left.\dfrac{\partial T}{\partial r}\right|_s = h(T_s - T_f)$ at the curved boundaries (3)

SOLUTION

THIS IS an extremely complicated problem to solve mathematically, for several reasons. The geometry of the coil is irregular, there are materials of different conductivities, the temperature at the boundary of the coil must simultaneously satisfy both Poisson's and Laplace's equations, and the boundary conditions at the curved external surfaces are difficult to handle. The only practical way to attack this problem is by a numerical method, and the "relaxation technique" is one possibility. This method is always laborious, however, and the added complications of this problem make any manual numerical procedure too time-consuming to be practical.

Instead, the problem will be set up in the same manner as would be done in using the relaxation technique, but once the finite difference equations are derived, a digital computer will be used to solve them.

The finite difference equation to be solved at interior points of the coil is, for a square grid having rod length δ (Fig. 3)

$$T_1 + T_2 + T_3 + T_4 - 4T_0 + \frac{Q\delta^2}{K_c} = 0 \tag{4}$$

the finite difference form of equation 1.

For an interior point of nonheat-producing material of given conductivity, the finite difference form of Laplace's equation holds.

For all other points, such as boundary points of the coil and different materials, the finite difference equations are derived by applying the conservation of energy law to each point 0 and the four surrounding points: 1, 2, 3, 4 (Fig. 3). The general form of the finite difference equation at each point throughout the sector will be

$$aT_1 + bT_2 + cT_3 + dT_4 - eT_0 + f = 0 \tag{5}$$

where the coefficients a through f are constants.

Full text of paper 58-790, presented at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Recommended for publication by the AIEE Air Transportation Committee.

P. B. Richards is with Jack & Heintz, Inc., Cleveland, Ohio.

The author wishes to express his sincere appreciation to J. B. Annable of the Jack & Heintz research and development department, who wrote the computer program and obtained the solutions on the IBM *650* computer. This program has been submitted to the IBM Program Library, World Headquarters, New York, N. Y., and can be obtained on loan from that organization.

For a point within or on the boundary of the coil, f is nonzero; if one assumes that the heat generation rate Q is constant, then

$$f = \frac{Q\delta^2}{K_e} \tag{6}$$

Actually, Q will be a linear function of temperature, since the resistance of the coil is a linear function.

Then

$$\frac{Q\delta^2}{K_e} = AT + B, \tag{7}$$

where A and B are constants, and $f = B$.

In solving the problem by the manual relaxation method, first temperatures are estimated at each grid point, then the left side of equation 5 is evaluated for each point. The result will be generally a nonzero number which is called the residual at that point. The correct solution is obtained by altering temperatures according to the "relaxation pattern" until all residuals are reduced to a minimum. The relaxation pattern can be seen from equation 5. If 1 degree is added to the temperature at T_0, the residual at the point 0 will be reduced by e units; the residual at point 1 will be increased by c units, because as far as point 1 is concerned, the present point 0 looks like point 3; and so on. In performing the relaxation manually, the entire area is covered to eleminate the largest residuals first, and overcorrection is used to hasten the solution.

A digital computer can calculate residuals, but cannot easily be instructed to perform the relaxation as a human does it. The most efficient way for a computer to solve the problem is to perform iterations on equation 5.

First, equation 5 is written as

$$T_0 = \frac{aT_1 + bT_2 + cT_3 + dT_4 + f}{e} \tag{8}$$

With each point in the region under study, there corresponds an identifying number, a set of coefficients a through f, and an initial estimated temperature. The computer is then programmed to solve equation 8 for the point designated 1, referring to the initial estimated temperatures at the four surrounding points. It then proceeds to the point designated 2, solving equation 8 for that point using the latest calculated or estimated temperatures at the four surrounding points. It repeats the process, going from one point to the next through the entire area, and then starts again at point 1, always using the latest calculated temperatures at the four surrounding points in solving equation 8 for a particular point.

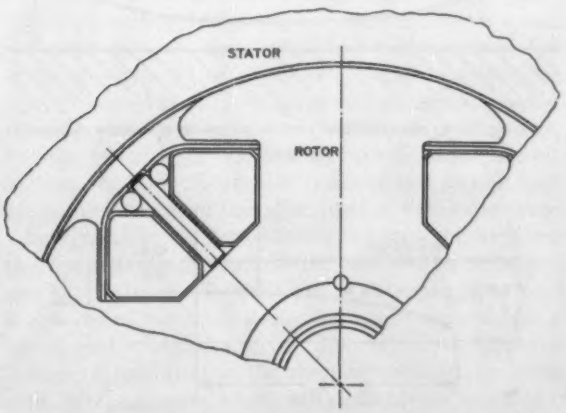


Fig. 1. Cross section of alternator rotor.

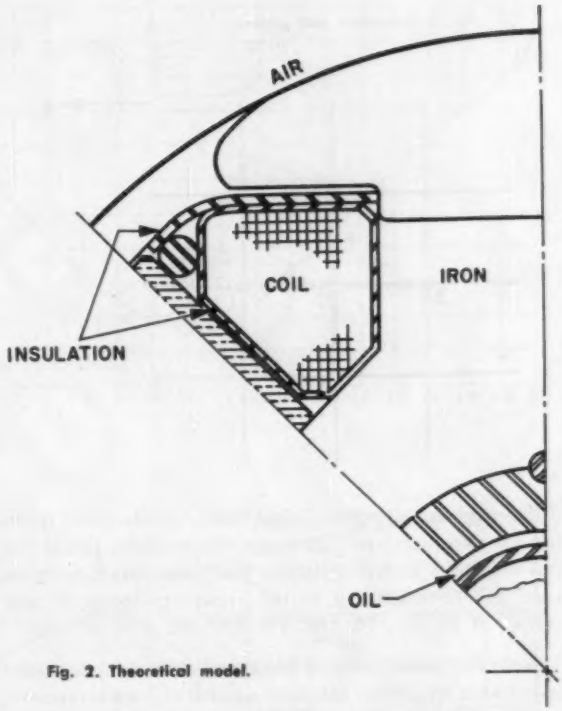


Fig. 2. Theoretical model.

A program has been written for the IBM *650* digital computer which will accommodate 704 grid points and 50 finite difference equations of the form of equation 8. The computer solves this equation at each point in 0.4 second, and performs calculations using 10 digits. Advantages of speed and accuracy over the manual relaxation method are obvious.

Convergence Criteria. Some criterion must be established for halting the machine when it has reached an acceptable solution. As in manual relaxation, the magnitude of the largest residual may be used as this criterion, but this does not have much meaning when using coefficients in equation 5 or 8 which differ by more than an order of magnitude. A more practical criterion to use in machine computation is the change in values between two successive iterations. In the present program, the machine stores the values at all points until the next succeeding iteration is finished. It then compares values at individual points, and if the sum of the magnitudes of

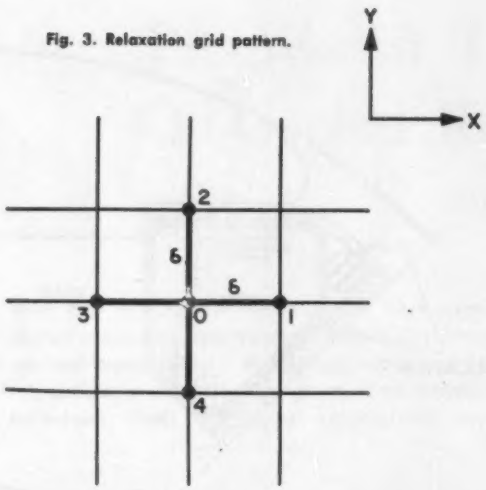


Fig. 3. Relaxation grid pattern.

differences for all points is less than a preassigned number for two successive iterations, the machine prints the last iteration and then halts. The preassigned number used as a criterion can, in the present program, be any power of 10, i.e., 10, 100, 1.0, 0.1, etc.

Rate of Convergence. The rate of convergence, or the speed with which the machine will furnish an acceptable answer for a given number of grid points and a given number of equations, will depend on the particular problem, of course. As a general rule, however, several factors play an important role in the convergence. One obvious factor is the initial estimated values at all nodal points. The closer these are to the correct solution, the shorter will be the solution time. Other factors are the ordering of points, the proximity of the boundary to interior regions, and the boundary conditions. For example, points should be ordered such that regions that the machine studies first are those regions (a) within which the initial estimates probably are the poorest, hence changes will be the greatest; and (b) which affect other regions, such as boundaries. If the functional values at the boundaries are known, convergence will generally be faster than if it is necessary to use a relationship between the normal derivative at the boundary and an exterior value.

Verification of Program. The program was checked by solving a problem for which independently obtained solutions were available, and which at the same time involved most of the complications of the heat transfer problem within the rotor of an electric machine.

The problem is that of determining the pressure at points on the boundary of an air foil in plane potential flow without circulation in a straight channel, such as a wind tunnel, with a uniform velocity $V\infty$ at infinity upstream and downstream. The author has derived an integral equation for the velocity on the contour, and for purposes of checking this program the equation was solved for an air foil in the form of an ellipse, whose major axis is five times its minor axis, in a straight channel whose width is 1½ times the minor axis. The major axis of the ellipse lies on the center line of the channel, Fig. 4. Once the velocity is determined, Bernoulli's equation can be used to obtain the pressure.

In the solution of the same problem by the iteration method, the appropriate form of the Laplace difference equation is written for the stream function at each grid point, the proper boundary conditions are inserted, and an initial estimated value for the stream function is assigned at each grid point. Because of the shape of the contour, symmetry exists about the two axes of the ellipse; therefore, attention can be confined to one quadrant of Fig. 4.

The geometry used for solving the problem is shown in Fig. 5, with the boundary conditions. For grid points adjacent to the curved boundary, the proper coefficients for the difference equation 5 were obtained directly from Shaw,[1] using his irregular-star method for curved boundaries. A total of 45 equations and 403 grid points were used.

The grid points were ordered so that the computer solved the points adjacent to the contour before proceeding deeper into the fluid for each iteration. The computer stopped when two successive iterations showed a total change of 10 for all grid points. The computer ran approximately 2½ hours before stopping.

The solutions obtained by the two independent methods are plotted in Fig. 6 as dimensionless pressure against the distance from the forward stagnation point. Agreement between the two solutions is excellent.

Temperatures in Rotor. In the rotor problem, temperatures were not known on the boundaries because the proportion of heat leaving through each surface was not known. Thus, the boundary conditions of equations 3 were used. Also, the heat generation rate in the coil was taken to be a linear function of temperature, so equation 5 with the condition of equation 7 was solved

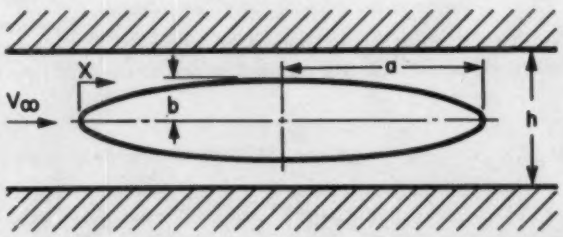


Fig. 4. Plane, potential flow past an ellipse in a straight channel.

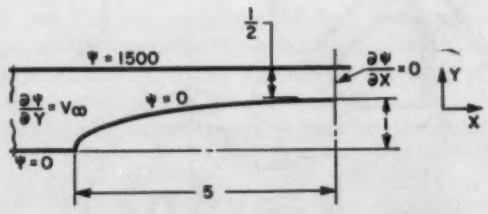
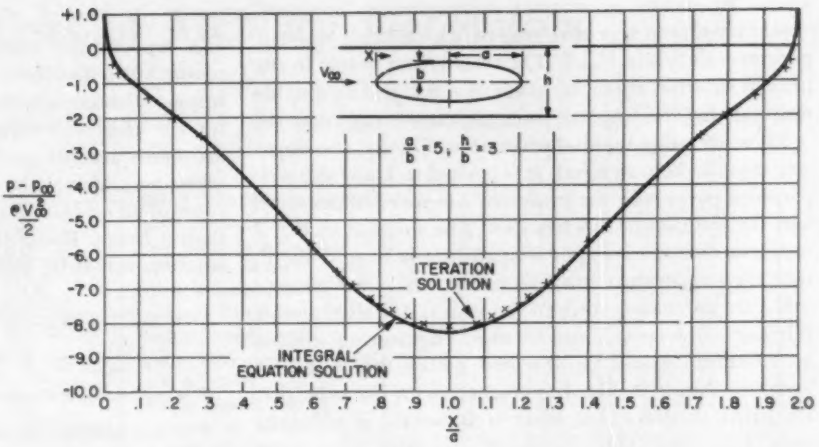


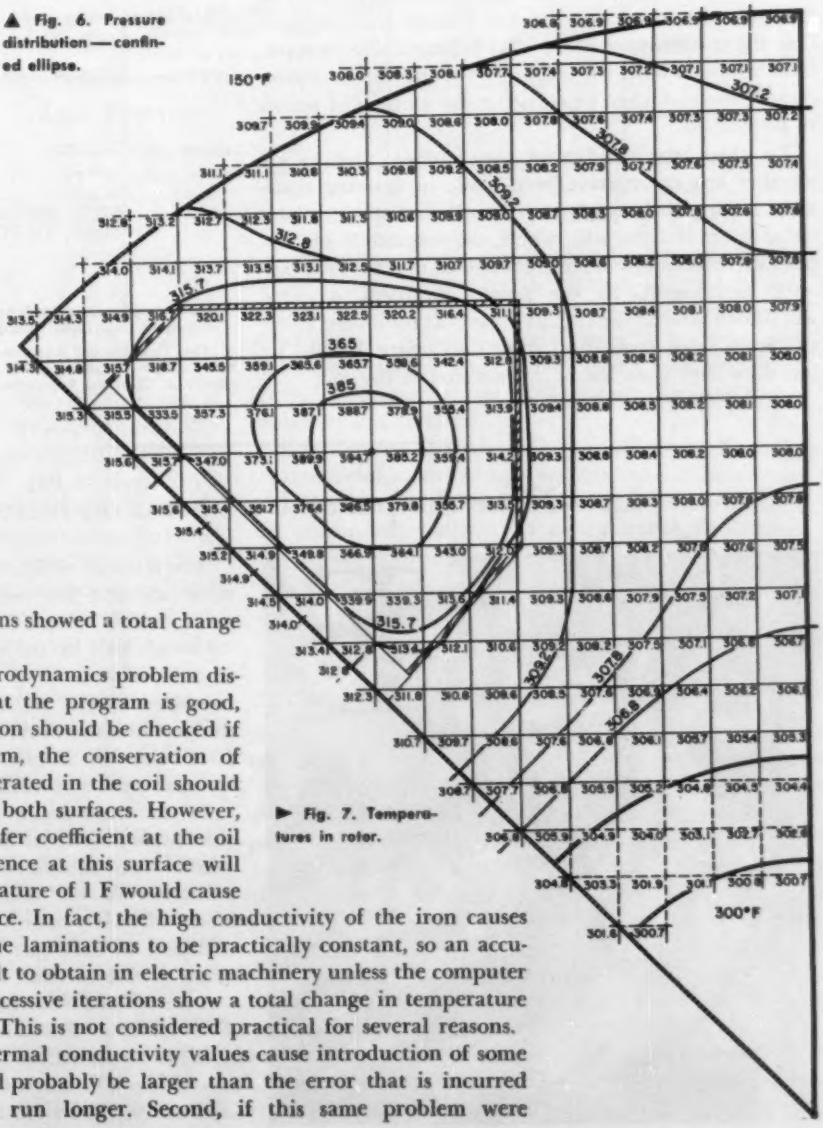
Fig. 5. Geometry for iteration solution of flow past ellipse.

at all grid points in the coil. Seven different conduction materials are present in the rotor. To simplify the writing of the finite difference equations, a square grid was used throughout, and the curved boundaries were approximated by straight segments. This does introduce an error in problems involving heat generation, because it increases the surface through which heat can leave the solid, allowing more heat to leave than is actually the case, and thereby causing the calculated temperatures to be lower than in practice. However, in this case, as in all oil-cooled rotors, most of the heat will leave through the small surface. A study[2] has been made of the error caused by approximation of curved boundaries by straight segments in such situations, and it is estimated that the actual error in temperature will be less than 2 F at the hot spot.



▲ Fig. 6. Pressure distribution — confined ellipse.

The temperatures at each grid point and several isotherms are shown in Fig. 7. A total of 245 grid points and 36 finite difference equations were used. The computer made one complete iteration every 98 seconds and was permitted to run until two successive iterations showed a total change for all grid points of 10 F.



► Fig. 7. Temperatures in rotor.

Despite the fact that the hydrodynamics problem discussed previously indicated that the program is good, the accuracy of the rotor solution should be checked if at all possible. In this problem, the conservation of energy states that the heat generated in the coil should equal the heat leaving through both surfaces. However, because of the large heat transfer coefficient at the oil surface, the temperature difference at this surface will be small and an error in temperature of 1 F would cause a large error in the heat balance. In fact, the high conductivity of the iron causes the temperature throughout the laminations to be practically constant, so an accurate heat balance will be difficult to obtain in electric machinery unless the computer is allowed to run until two successive iterations show a total change in temperature for all grid points of, say, 1 F. This is not considered practical for several reasons.

First, inaccuracies in the thermal conductivity values cause introduction of some error in temperature, which will probably be larger than the error that is incurred by not having the machine run longer. Second, if this same problem were

solved by means of manual relaxation, a "solution" would have been accepted long before reaching the temperatures shown in Fig. 7. The residuals at points in the present solution are of the order of ± 0.1, and acceptable residuals for the Laplace finite difference equation are ± 2.0 when using manual relaxation. Finally, the objective must be kept in mind. It is desired to know the temperature pattern in the rotor, the hot-spot temperature, and the location of this hot spot. The solution of Fig. 7 indicates that the hot-spot temperature is around 400 F, that the temperature gradient in the coil is quite steep, and that the temperature in the iron is, for all practical purposes, constant. Thus, in most engineering studies, a "solution" would be accepted before the degree of accuracy shown in Fig. 7 is reached, with the note that increased accuracy, for what it is worth, is obtained only at considerably increased computer time. The present solution was obtained after almost 4 hours on the computer, and in the last hour temperatures did not change more than 2 or 3 degrees. Indeed, realizing now that the temperature in the iron is practically constant, later studies would use a larger grid size in the region outside the coil, thereby reducing the number of points to be studied.

To check the validity of the solution and to see whether any errors have been made in deriving equations or in punching cards, it is still wise to get a heat balance around the coil, where the magnitude of temperature differences is large enough to make a heat balance meaningful. In the present problem, a curve was drawn around the coil, and the heat computed along the "rods" that cross this curve. This figure differed by less than 20% from the heat generated in the coil.

SUMMARY

A METHOD has been presented for determining the temperature distribution in rotating electric equipment using an iteration technique that has been programmed for the IBM *650* digital computer. The program will accommodate 704 grid points and 50 finite difference equations. Using this program, temperatures in the rotor of an oil-cooled alternator were determined in less than 4 hours. Doing this same problem by manual relaxation would be economically unfeasible.

NOMENCLATURE

T = temperature, degrees F

Q = heat generated per unit volume, Btu per hour per cubic foot

K = thermal conductivity, Btu per hour per cubic foot per degree F

h = heat-transfer coefficient, Btu per hour per square foot per degree F

x, y = rectangular co-ordinates

r = radial co-ordinate

Subscripts: s = surface
f = fluid
c = coil

REFERENCES

1. An Introduction to Relaxation Methods (book), F. S. Shaw. Dover Publications, Inc., New York, N. Y., 1953.

2. The Temperature Distribution in a Nuclear Reactor Pierced by Circular Cooling Channels, P. B. Richards. *Symposium Series*, American Institute of Chemical Engineers, New York, N. Y., vol. 50, no. 11, 1954.

Low-Noise Amplifier Uses Semiconductor Diodes

A new device which has exciting possibilities as a low-noise uhf and microwave amplifier is under development at Bell Telephone Laboratories, New York, N. Y. Although still in the experimental stage, preliminary results indicate that this device, which uses semiconductor diodes as the active elements, can improve the performance of many types of microwave receivers. It is relatively simple to construct and operate, and shows prospects of having a long life.

In the illustration, M. Uenohara (*left*) and G. F. Herrmann (*right*), of Bell Telephone Laboratories, are shown with equipment for studying the amplifying properties of the nonlinear capacitor semiconductor diode. Mr. Herrmann is holding the special diode and enclosure in his right hand, and is about to insert it in the proper location in the waveguide structure.

A pump frequency of 12,000 mc enters from the left. The signal, in this case 6,000 mc, comes in from the right, is amplified, and reflected back inside the same waveguide. The incoming and outgoing signals may be separated by a ferrite microwave circulator.

Loss Tests of McNary Generators

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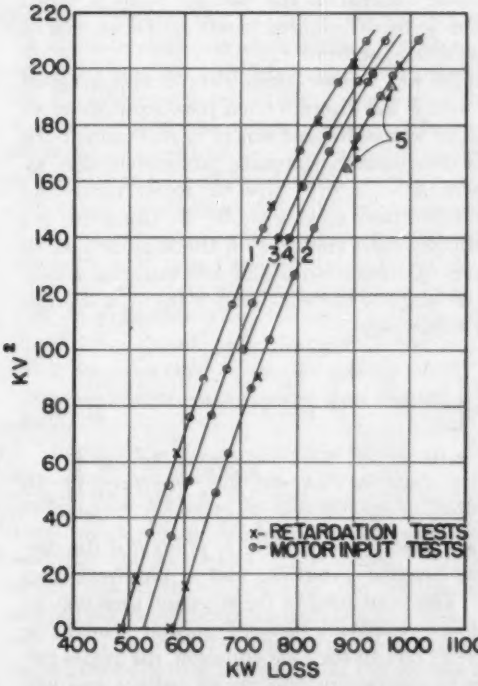

Fig. 1 (*left*). Friction and windage plus core losses vs terminal voltage squared. Curve 1—turbine uncoupled; Curve 2—turbine coupled, 0 gate, 16½ degree blades; Curve 3—turbine coupled with generator air baffles, 0 gate, 16½ degree blades; Curve 4—same as Curve 3 except 32 degree blades; Curve 5—same as Curve 4 except 75% gate.

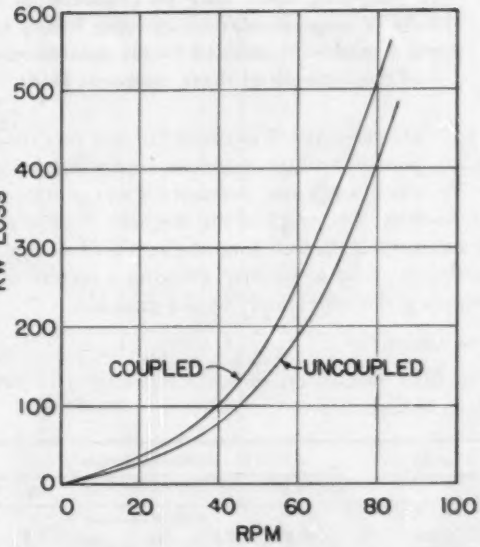

Fig. 2 (*right*). Friction and windage losses vs speed.

FIELD TESTS for determination of the losses of large hydroelectric generators are almost invariably made with the unwatered turbine connected to the generator shaft. The value of friction and windage losses obtained thus includes the losses of both the turbine and generator. This total value normally is apportioned between the two machines in the same ratio as their respective calculated values in accordance with AIEE Standards. For this purpose, the calculated value of turbine windage is determined by means of an empirical formula given in the American Society of Mechanical Engineers (ASME) Power Test Code. In many cases, it has been suspected that this formula yields highly inaccurate values that result in significant errors in the efficiency tests on large hydroelectric generators with Kaplan-type turbines.

When testing the last two 73,684 kva, 85.7 rpm generators at the McNary Project, measurements of windage and friction losses were made both with the Kaplan turbine connected and disconnected. The connected tests also included measurements at different turbine blade angles and gate openings to show the effect of these items. The results of these tests are shown in Fig. 1. The difference between curves 1 and 2 at the zero axis is 92 kw and represents the test value for the turbine windage and friction loss.

The turbine windage loss was calculated to be 102 kw using the ASME turbine windage formula. The thrust bearing friction attributable to the turbine and turbine guide bearing friction were calculated by the generator and turbine manufacturers to be 38 kw and 12 kw respectively. These combine to a total calculated friction and windage loss of 152 kw as compared to the measured loss of 92 kw.

In an attempt to separate the windage losses from the friction losses, curves of total windage and friction losses vs speed were plotted as shown in Fig. 2 for the coupled and uncoupled condition. By assuming that the windage loss varies as the cube of the speed and the friction loss directly with speed, equations can be written in terms of the two components which approximate these curves. Where N = rpm, these equations are:

$$\text{Coupled: Kw loss} = 7.05 \times 10^{-4} N^3 + 1.57N$$

$$\text{Uncoupled: Kw loss} = 6.44 \times 10^{-4} N^3 + 0.97N$$

At rated speed, these equations indicate a turbine loss of 40-kw windage and 52-kw friction.

Comparing the calculated turbine windage loss of 102 kw with the 40-kw value determined from the foregoing analysis, it is apparent that the major error in the turbine calculated value of windage and friction is in the windage component as determined from the ASME formula.

Digest of paper 57-939, "Friction and Windage Loss Tests of McNary Generators with Coupled and Uncoupled Turbine," recommended by the AIEE Power Generation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1958.

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Field Strength Near Rectangular Conductors

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High magnetic fields may be produced in the vicinity of large conductors carrying heavy currents. A method is outlined for the determination of the strength of these magnetic fields.

A HIGH VALUE of direct current in a conductor produces a high magnetic field which may affect electromagnetic instruments and control gear in the vicinity. The value of the magnetic field in oersteds at a distance d, in feet, from the center of a large round conductor, solid or tubular, carrying a current of I amperes is given very simply by the equation

$$H = 0.00656\ I/d \qquad (1)$$

A brief tabulation of some representative values is given below.

Current, amperes.	Distance d, feet					
	1	2	5	10	20	50
	Field H, oersteds					
5,000	32.8	16.4	6.6	3.3	1.6	0.7
10,000	65.6	32.8	13.1	6.6	3.3	1.3
20,000	131.2	65.6	26.2	13.1	6.6	2.6
50,000	328.0	164.0	65.6	32.8	16.4	6.6
100,000	656.0	328.0	131.2	65.6	32.8	13.1

In the electrochemical industries, including the manufacture of aluminum metal from alumina, the conductor is usually rectangular in shape, consisting of a group of rectangular bus bars. Inasmuch as the conformation is not circular, equation 1 for field strength cannot be used directly.

To obtain a working procedure to determine the field strength adjacent to a rectangular conductor carrying a high current, it was decided that the laminated bus could be considered as a solid conductor within its outside outline dimensions and that the point at which the field was to be determined would be on an axis of the conductor cross section.

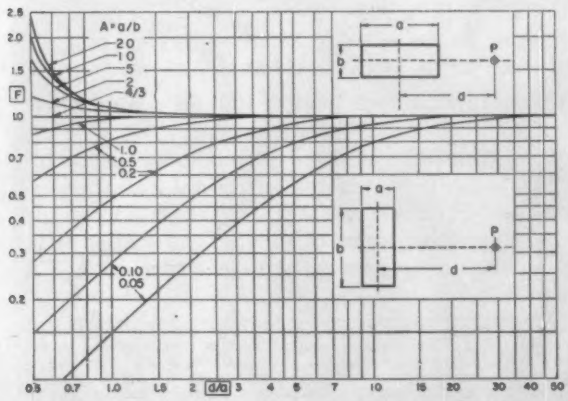

Fig. 1. Plot of values of modifying factor F, used in obtaining magnetic field strength, in oersteds, near a large rectangular conductor carrying a heavy current.

Referring to Fig. 1, dimensions a and b were assigned as shown, with d the distance from conductor center to the point P, at which the field was to be determined. To allow for a dimensionless formula, parameters were assigned where $A = a/b$, a type of aspect ratio, and $D = d/b$. In collaboration with W. N. Goodwin, Jr., retired, formerly chief engineer for the Weston Electrical Instrument Corporation, a complete integration over the entire rectangular current path for the field at point P gave the following:

$$H' = H\left\{\frac{D}{A}\left[(2D+A)\tan^{-1}\frac{1}{2D+A} - (2D-A)\tan^{-1}\frac{1}{2D-A} + \frac{1}{2}\log\frac{1+(2D+A)^2}{1+(2D-A)^2}\right]\right\} \qquad (2)$$

In this equation, H is the field at point P if the conductor were circular insection, and is obtained from equation 1. The remainder of the equation then may be considered as a modifying factor, F, so that it might be said that $H' = HF$. In the long equation, the angles corresponding to inverse tangents are in radians and natural logarithms are used.

Values of F have been calculated for rectangular conductors of various shapes, having a width at right angles to the axis to the point P in question from 20 times the thickness to a width 1/20 of the thickness, and these are plotted in Fig. 1 using, however, the ratio $A = a/b$ to identify the several curves, and d/a as the ordinates to simplify the presentation.

Essentially, then, to determine the the flux density at point P, determine a/b and select the appropriate curve or interpolate between two curves. Determine d/a and select the appropriate vertical ordinate. The intersection of the ordinate and curve gives the value of F on the scale at the left. Then, the value of the field, in oersteds, is $H' = 0.00656\ I/d \times F$.

Note that a field of 5 oersteds is ordinarily the maximum field strength for which shielded instruments are rated. In higher fields, additional shielding is required. Alternately, self-shielded structures such as the Weston core magnet mechanism may be adequately shielded for upwards of 100 to several hundred oersteds, depending on the particular mechanism and casing used.

Full text of paper 58-367, presented at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Recommended for publication by the AIEE Indicating and Integrating Instruments Committee Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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A System for Gaging Plating Thickness

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THE NONDESTRUCTIVE MEASUREMENT of cladding thickness when the cladding metal and base metal are nonmagnetic has presented a major problem for a number of years. It is the purpose of this article to describe a system which employs pulsed eddy currents for gauging cladding with a minimum effect from probe-to-metal spacing variations.

A small ferrite-cored coil with its axis perpendicular to the surface of the metal was used to project an electromagnetic field into a coated metal. When the coil was close to a metal, there was a change in its impedance. The magnitude of the impedance change depended upon the electrical properties of the metal, the cladding thickness, and the probe-to-metal spacing. This impedance change was measured with the aid of a bridge circuit.

The bridge was excited by a pulse which was shaped like the positive half of a sinusoidal wave. Two probes were arranged in the bridge in order to balance out the impedance changes that were not due to cladding thickness and probe-to-metal spacing. The bridge was balanced, and then the test probe air gap was varied to introduce an unbalance. The output voltage pulse was as indicated in Fig. 1a. It was discovered experimentally that one point on the output pulse did not vary in amplitude with probe-to-metal spacing, but the amplitude of this point did vary with cladding thickness. This is shown in Fig. 1b. This point will be called the crossing point. An analysis of the bridge circuit was made and the results indicated that the crossing point does exist.

To measure cladding thickness independent of probe-to-metal spacing, the amplitude of the crossing point must be measured with no interference from the peak amplitude of the bridge output pulse. This was accomplished in the following manner. A sampling pulse of about 15 millimicroseconds was added to the bridge pulse at the crossing point. This fast-rise time pulse was generated by charging a section of transmission line and then discharging the line through its characteristic impedance with an 884 thyratron acting as a switch. The sampling pulse is shown in Fig. 1c. A variable delay line in the grid circuit of the thyratron positioned the sampling pulse. The delayed sampling pulse and the bridge pulse were applied to the grids of a twin triode mixer circuit. This circuit added the pulses in the cathode circuit with a minimum interaction and distortion. The output of the mixer is shown in Fig. 1d. The sum of the pulse voltage from the bridge circuit at the crossing point and the sampling pulse voltage gave the indication of cladding thickness. A diode peak rectifier circuit was used to measure this sum. The output voltage of this peak voltmeter was independent of the mixer output pulse except at the point of sampling.

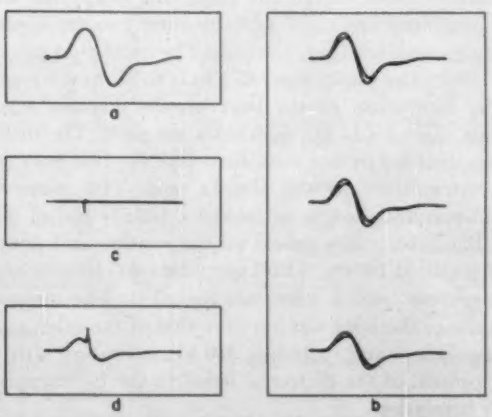

Fig. 1. Waveforms from a cathode ray oscilloscope.

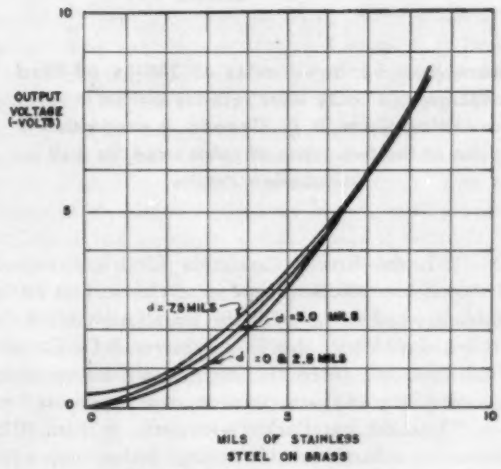

Fig. 2. Output of the entire system.

The output of the peak voltmeter was amplified with a difference amplifier. This amplifier provided a high gain and a simple method for balancing out the direct voltage that contained no cladding information. The results for nonmagnetic stainless steel coated on brass are given graphically in Fig. 2 where d is the probe-to-metal spacing. It should be noticed that the readings are nearly independent of the probe-to-metal spacing.

Digest of paper 58-933, recommended by the AIEE Special Instruments and Auxiliary Apparatus Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and Air Transportation Conference, Buffalo, N. Y., June 22-27, 1958. Scheduled for publication in AIEE *Communication and Electronics*, 1958.

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The Vancouver 230-Kv Oil-Filled Cables

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More than 14 circuit miles of 230-kv oil-filled underground cable were recently placed in service in Vancouver, B. C., Canada. A description is given of the two types of cable used, as well as installation details.

IN 1957, the British Columbia Electric Company Limited successfully placed in service its first 230-kv underground cables with the installation of 14 circuit miles of oil-filled cable in Vancouver, B.C., Canada. The cables supply three distribution substations which serve some of the 12-kv distribution areas in or near Vancouver. Thus, the installation is unusual, in that 230 kv has become a subtransmission voltage rather than a primary transmission voltage. The lines differ in two major respects from previous 230-kv cable installations, substantially all of which are in European countries. The European lines, other than special short leads in stations, are either of the high-pressure oil-filled pipe type or the low-pressure self-contained type, directly buried with sheaths short circuited. The Vancouver lines are installed in ducts, with special bonding used to minimize sheath losses.

THE CABLES

ONE CANADIAN AND ONE BRITISH MANUFACTURER were invited to submit proposals to the requirements of the utility's specification. This specification was purposely quite brief and nonrestrictive as to details of design. The main requirements of the specification were as follows:

1. Cables to be installed in ducts.
2. An ampere capacity of 700 amperes at 80% load factor, each circuit to be installed in a separate duct bank.
3. An impulse withstand of 900 kv.
4. Cable to be either oil filled or gas filled.
5. Association of Edison Illuminating Companies (AEIC) Specifications for Impregnated Paper Insulated Lead Covered Cables "Oil Filled Type" to rule where applicable.

One manufacturer offered either gas-filled or oil-filled cable to comply with this specification. Oil-filled cable was selected, mainly on the basis of satisfactory experience reported for this type of cable in European installations. An analysis of the proposals led to the decision to divide the contract between the two suppliers. The detailed make-up of the cables supplied by the respective manufacturers is given in Table I. The disparity in conductor size between the two cables for identical basic assumptions arises from the methods used by the respective manufacturers in making the computations. The Canadian computation was made in accordance with the IPCEA method and using the National Electric Light Association (NELA) duct heating constant of $H = 1.04$ for three loaded cables. The British computation was made by a method developed by the manufacturer and not available in the literature. The method is not the same as that recently proposed by Neher and McGrath,[1] but gives about the same results for conductor size. A few scattered checks of duct heating constants under service conditions in Vancouver indicates that the 1,500-MCM (thousand circular mil) conductor size is very conservative. If this is substantiated by field tests, the British lines will be given a higher rating. On the other hand, the Canadian cable will be derated or operated at a higher temperature if found necessary.

Canadian Cable. A total of approximately 4 circuit miles of the aluminum-sheathed Canadian cable was installed for two circuits, each with an elevation difference of 356 feet between their respective cable terminals. Both circuits are fed from a single oil-pumping plant without stop joints or additional oil feeds. The Canadian manufacturer followed his established practice of using a segmented hollow conductor designed as shown in Fig. 1. This construction gives an unusually smooth outer surface, a smooth inner core which requires no supporting spiral, and a highly compacted conductor. The conductor shielding consists of three metallized paper tapes. The inner one is applied with the metallized side outwards, the outer two are applied with the metallized side inwards. The insulation consists of high-density paper tapes 2½ mils thick in the region of the conductor. In the lower-stressed regions lower-density tapes 5 and 6½ mils thick are used. The insulation is shielded by one metallized tape applied outwards and intercalated with a Manila tape. The protective jacket was designed to withstand a factory test of 5 kv d-c. The cable easily passed all the routine and sample tests required by the AEIC specifications. In two high-voltage-time tests, a joint was included. The temperature rise of the joint was less than that of the cable at all voltages up to and including 430 kv, indicating satisfactory control of the dielectric losses in the hand-applied joint insulation.

British Cable. Approximately 10 circuit miles of the

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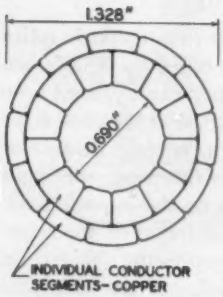
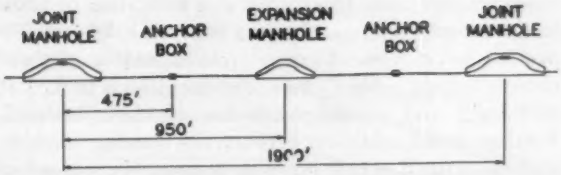


Fig. 1 (left). Conductor construction detail, Canadian cable. Fig. 2 (right). Typical duct and manhole arrangement, British cable.



reinforced lead sheath British cable were installed to complete two of the four initial circuits. Each of these circuits is sectionalized by two stop joints, and multiple groups of oil tanks of the prepressurized type are employed to feed each oil section.

While the British cable is not in strict accordance with the AEIC specification with respect to insulation thickness, it was accepted as being in line with the current European trend toward higher electrical stresses for high voltage cables. Taking the impulse withstand strength of the insulation to be at least 1,300 volts per mil, as indicated in Note 1 of Table V of the AEIC specification, the thickness required for 900 kv is 695 mils. A production sample of the British cable successfully withstood an impulse test at 1,050 kv, an adequate margin above the tender requirement. It is interesting to note that the British supplier offered an alternative proposal for a cable with 600 mils of insulation. This alternative was rejected in favor of the more conservative proposal.

In the conductor region, the insulation tapes are 3 mils thick. In the more lightly stressed regions, 5¼-mil and 7½-mil tapes are used. The conductor shielding consists of three metallized paper tapes, the inner two being perforated and applied with the metallized side outwards, the outer being plain with the metallized side inwards. The insulation shielding consists of a metallized paper tape overlaid by a copper woven fabric tape to give protection against risk of damage during sheathing, yet insuring electrical contact with the sheath. The sheath was extruded from a screw-type press. It is reinforced with two bronze tapes ¾ inches wide by 8 mils thick laid in tandem over an impregnated copper woven cotton bedding tape. The reinforced sheath is designed to withstand 75 psi continuously and 50 per cent higher pressures on transients. The reinforcement is protected from corrosion by a PVC-rubber-PVC (polyvinyl chloride) jacket. There is no outer lead sheath. The jacket is designed to withstand a factory test of 10 kv d-c. The rubber part of the jacket is self-vulcanized, not cured under heat and pressure. The cable is finished with two layers of hessian tape; the inner hessian is bituminized; the outer hessian is liberally coated with an aqueous suspension of graphite. The cable easily passed all the routine and sample tests prescribed by the AEIC specification, except for modifications in the tests necessitated by the inability of the factory test equipment to supply the heavy charging kva associated with a-c overvoltage testing.

Table I. Cable Construction Details

	Canadian Cable	British Cable
Conductor size, circular mils	1,150,000	1,500,000
Hollow core support	none	steel spiral
Core diameter (clear), inches	0.69	0.470
Conductor diameter, inches	1.328	1.550
Conductor shielding	3 metallized paper tapes	3 metallized paper tapes
Insulation thickness (nominal), inches	0.835	0.695
Insulation diameter, inches	3.000	2.940
Insulation shielding	*	†
Sheath material	aluminum	alloy lead (0.2% Sn, 0.075% Cd, remainder Pb)
Sheath thickness, inches	0.130 minimum	0.118 minimum
Sheath diameter, inches	3.330	3.216
Reinforcement bedding		impregnated cotton tape
Reinforcement		2 tin bronze tapes
Jacket material	neoprene tape	PVC-rubber-PVC
Over-all diameter, inches	3.60	3.576

* One 5-mil metallized paper tape intercalated with Manila tape
† Metallized paper and copper woven fabric tape

DUCT BANK DESIGN

THE UTILITY'S SPECIFICATION ruled out a directly buried installation for the following reasons:

1. The approval of the municipal authorities for a directly buried circuit operating at this voltage would have been difficult, if not impossible, to obtain.

2. In common with general North American practice, the B.C. Electric Company was using duct banks encased in concrete for its existing 4-kv, 12-kv, and 60-kv underground circuits. For the initial installation of 230-kv cables, it was deemed prudent to provide the greatest protection practicable against external mechanical damage.

3. The opening of sufficient trench at one time to permit efficient employment of labor in laying buried cables would have caused excessive interference to vehicular traffic on city streets.

4. It was estimated that the splicing pits would have to remain open at least one month for splicing and pressure testing of splices. This was considered excessive for the large pits which would have been required.

Engineering advice with respect to the design of the duct system was an integral part of the supply contracts. The available length of seamless tubing for the aluminum sheath limited the Canadian supplier to 700-foot cable lengths. With these comparatively short section lengths, the duct layout was quite conventional. The jointing manholes are 7 feet by 30 feet, with 7 feet headroom. A radius of 7 feet is used for cable training in the manhole and a minimum 4-foot offset width is obtained with these manhole dimensions.

The duct line arrangement for the British cable is

novel because cable lengths up to a maximum of 1,950 feet are used. Nearly all lengths are over 1,800 feet. To provide for movement under cyclical loading of these extremely long cable sections, the duct line is broken at midlength and an expansion bay manhole inserted. Further, at the midpoint between the splicing manhole and the expansion bay, the cable is securely anchored in a 42-inch clamp. These brass anchor clamps are installed in precast concrete anchor boxes directly buried in the duct line. The anchor clamps prevent movement of the cables on gradients due to gravitation, thermal expansion and contraction, or vibration induced from heavy traffic. The use of anchor clamps is also expected to equalize the cable movement at each end of the half length. Fig. 2 illustrates the general arrangement of the duct line for the British cable.

Since operating experience with 230-kv duct-lay cable of the British design did not exist, generous manhole dimensions were adopted to insure satisfactory sheath life under very severe cyclic loading conditions. The supplier used, in his design, published data of American investigators in the field of cable movement, sheath strain, and sheath life. This was supplemented by extensive dummy manhole tests simulating the proposed installation. The values selected for the factors entering into the determination of manhole size were

Daily temperature range	33 C
Assumed ratio of actual movement at duct mouth to theoretical free bar expansion	75 per cent
Daily cable movement at manhole duct mouth	2.5 inches
Allowable change in sheath strain per movement cycle	0.14 per cent

The principal dimensions and cable training for the various types of manholes used on the British cable circuits are given in Fig. 3. The use of these extremely large manholes was a factor in the high cost of duct construction for these lines. They were considered a prudent investment, however, in view of the lack of extensive operating experience with this reinforced lead sheath cable in duct-lay installations. Large amounts of cable of this design have operated successfully for many years in direct burial installations.

SPLICES AND POTHEADS

British Through Splice. The British through splice is approximately 58 inches long between the lead wipes. The connector is a compression type ferrule pressed onto a tubular silver steel mandrel inserted in the central oil duct. It contains no valves. The connector consists of three copper pieces, namely, a ferrule ring, the main ferrule, and a second ferrule ring on the opposite conductor end. First one ferrule ring and then the other is pressed with a 5-ton press, compressing the ferrule ring and conductor uniformly all around onto the mandrel. Finally, this operation is repeated at each end of the main ferrule making a total of four presses for each joint. A ferrule screen consisting of a sheet of aluminum foil is applied overlapping the termination of the metallized papers forming the conductor screen. Paper tape is hand applied over the inner steps of the insulation. The remaining insulation, including the build up to the cable diameter and also the stress cone and tape reinforcement to the final joint diameter consists of paper rolls which are wrapped on with the first turn of the new roll interleaved with the last turn of the previous roll.

Canadian Through Splice. The Canadian through splice is approximately 87½ inches over-all. The connector is a one-piece flush type compression ferrule which is pressed on a stainless steel insert in the conductor core. Three presses are made on the ferrule. The insulation is hand applied paper tape throughout. The cable insulation stepping consists of 54 steps, each with ½-inch treads. While taping, heat lamps are used to keep the insulation warm. The average time for applying paper tape including stress cone reinforcement was 14 hours.

Stop Joints. The only stop joints in the present circuits are on the British cables since none were required on the aluminum sheathed cables. A diagrammatic drawing of the stop joint is shown in Fig. 4. This stop joint is of the "single end stop" design. A porcelain insulator forms the stop tube on the left-hand end of the joint. The compression type copper connector is a two-piece unit. Each connector half has a threaded valve housing

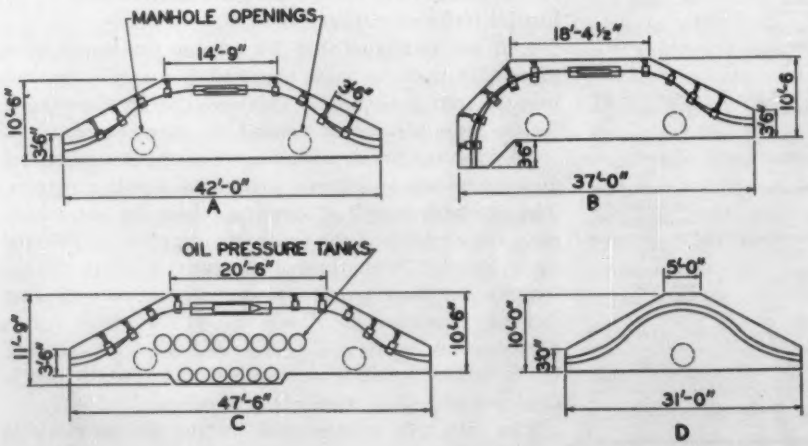


Fig. 3. Manhole layout, British cable.

A. Through straight joint manhole
B. 90-degree turn straight joint manhole
C. Stop joint manhole
D. Expansion bay manhole (no joints)

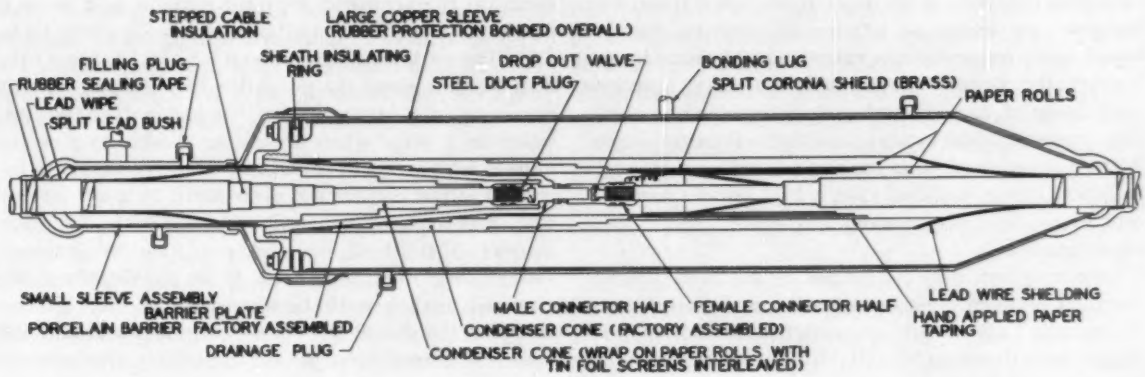


Fig. 4. Stop joint, British cable.

on the top which contains a "drop-out" valve held in place during assembly by a small nut. The connector and conductor are compressed onto the steel mandrel with a hydraulic press. Two presses are made on each connector half. Split copper ferrules are fitted over the press recesses. After the joint is completed, the oil pressure in the joint casing is raised until it exceeds the core pressure. This causes the valve to drop permanently, which permits the cable core oil to flow into the end section within the porcelain stop tube. If the drop-out valve should fall prematurely, it easily can be replaced by removing the threaded valve housing with a special tool.

Paper rolls are used throughout in insulating the stop joint. The only hand applied paper tape in the joint is used between the shallow steps at the small end of the condenser cone and the stress cone paper rolls at the end of the joint.

Potheads. In the British pothead design, the terminal stalk is a one-piece copper connector which is pressed on the conductor in the same manner as the joint connector. Stress control is achieved by building a condenser cone of paper rolls with tin-foil screens interleaved at the proper position within each roll. The cable insulation is stepped prior to the application of the paper rolls. All rolls are 5-mil paper and all screens are 3-mil tin foil. The lower rolls are preshaped to achieve a smooth stress profile. A lead wire stress control screen is fitted over the profile. The porcelain is of English manufacture with double skirts. A copper corona shield is supplied over the top plate of the pothead.

The pothead for the Canadian cable has a two-piece stem connector with a flexible braid connection between the upper and lower stem. For this pothead, stress control is achieved by the application of two preformed paper cones. These two cones are preformed in the factory, put through a drying and impregnating cycle similar to that for oil-filled cable and shipped in sealed compound-filled containers. On site, the cone is heated in its container and immediately, with a minimum of handling, slipped over the cable insulation and tightened onto the cable from the bottom upwards. These cones differ from the type used on the British cable in that they are put on as a complete unit and not wrapped on layer by layer. The outer cone is installed over the inner cone in a similar manner to complete the stress profile. These preformed paper roll stress cones are very easily handled in the field. The porcelains for the Canadian cable potheads are high-pressure porcelains of English manufacture.

BONDING

High ampere ratings could not be obtained with reasonable sizes of conductors if sheath losses were allowed to occur. To get the required rating of 700 amperes, both manufacturers elected to eliminate sheath losses by the use of special bonding of the Kirke-Searing type.[2] With this scheme, the full voltage induced in one section of cable appears between sheath and ground in the cross-bonded manholes. For the British cable, the voltage is about 60 volts; for the Canadian cable, it is about 20 volts.

The three sheath lengths of each cross-bonded section of the British lines were nearly enough equal, so that no special problems arose in laying out the bonding. In the case of the Canadian lines, there were two sheath lengths left over, adjacent to one terminal, after five cross-bonded sections were laid out. One end of each of the two lengths was grounded solidly to the terminal ground mat through a 4/0 cable. With only one end grounded, sheath losses are eliminated, but a direct metallic circuit is provided for the return of fault current from each length. The last solid-bonded point of the Kirke-Searing bonding adjacent to this terminal was also connected to the terminal ground mat. This provided a metallic circuit for the return of fault current from the cross-bonded part of the line. Ground rods were installed in all manholes, but the bonds at the solid-bonded manholes were not connected to the rods. It is felt that such grounds are not needed to control relationship to ground of a-c sheath voltages, and may lead to undesirable circulation of stray direct currents.

SHEATH SURGE VOLTAGES

High surge voltages have been observed elsewhere on specially bonded cable sheaths[3] during line switching.

Switching tests were made on each line when it was first energized to determine whether detrimental voltages would occur. Surge voltages exceeding 40 kv were found. Neither the British nor Canadian protective jackets were designed to withstand such voltages safely; therefore, protective devices were installed to limit the surges. Because the phenomenon has received little attention in technical literature other than a 1935 paper,[3] some details of the field observations and protective measures are appended.

Switching tests were carried out on one of the circuits installed between Newell Substation and Hill Avenue Terminal. This circuit was switched at Newell Substation with the other Newell–Hill line connected to the bus at Newell Substation. Observations were made at the fourth manhole (2,700 feet) from Newell Substation, and also at the manhole 700 feet from the Hill Avenue Terminal. Surges occurred which flashed over the sheath insulators on several occasions in both manholes. Measurements of the surge voltages by klydonograph indicated voltages in excess of 40 kv across the sheath insulator. The oscilloscope indicated about a maximum of 8 kv across the sheath insulator, although the instrument happened to be connected to an insulator which did not flash over. It was significant to note that no burned areas were observed at the locations of the flashovers. Apparently, the available energy was insufficient to produce any permanent marks.

The occurrence of these high surge voltages posed an urgent problem, inasmuch as it was desired to keep the lines in service. However, to do so without switching them frequently was impractical. The large charging kva of the cables caused the interconnected systems to trend toward instability during the night hours and other low-load periods, so that it was necessary to switch some of the cables out at such times. During the day, however, the lines were required in service for load transfer purposes and for system security. These conditions only prevailed for a few weeks until three new generating plants were started up, but in the interim an immediate solution was necessary. An obvious method was to short circuit all the bonding and operate the cables with sheath losses until suitable protective devices were decided upon and obtained. The cables had ample capacity to carry the initial load with short-circuited sheaths. This was not favored because it meant cutting the insulation on the bond wires to make the short circuit and restoring it later. A permanent solution was desired.

Capacitors could be used to reduce the surge voltages, but consideration of the voltage rating and capacity required for the purpose indicated that this would be a very expensive solution. Low-voltage lightning arresters were also considered, but no standard arrester was available which had the required combination of impulse and 60-cycle characteristics.

Telephone-type protectors, Western Electric model *118A*, were immediately available in quantity and were adopted. A description of experimental models quite similar to the production model has been given.[4] The electrical characteristics are quite variable as it is not a precision device. The impulse breakdown is about 1.5 to 3 kv. The a-c breakdown is about 0.8 to 2 kv. Some concern was felt about the possibility of a-c follow current persisting in a protector that has had a discharge initiated by a surge when energizing a cable to pick up normal load current. The ability of the protector to interrupt follow current was determined by a test on one unit. The requirements were estimated in the following manner. At full load, the maximum open-circuit sheath voltage to ground is 60 volts. With the sheaths short-circuited, as they would be when the protectors are discharging, the sheath circulating current is less than 400 amperes. Accordingly, an a-c test source was selected having an open-circuit voltage of about 100 volts and a current of about 400 amperes when connected across a discharging protector. On the one unit which was tested, the 400-ampere arc went out as desired when the initiating impulse was shut off. It was felt that the test voltage of 100 volts provided ample margin above the actual sheath voltage of 60 volts to insure extinction of the a-c arc under service conditions.

Table II. Comparative Costs

Type	Cost	Per Cent of Total	Cost per Mile
British Cable			
(9.9 circuit miles—reinforced lead sheath)			
Ducts and manholes	$1,276,583	32.6	$128,947
Cables and accessories	2,055,950	52.5	207,672
Installation	528,288	13.5	53,363
Engineering and miscellaneous	55,710	1.4	5,627
	$3,916,531	100.0	$395,609
Canadian Cable			
(4.2 circuit miles—aluminum sheath)			
Ducts and manholes	$ 638,300	32.0	$151,976
Cable and accessories	895,037	44.9	213,104
Installation	420,038	21.0	100,009
Engineering and miscellaneous	42,397	2.1	10,095
	$1,995,772	100.0	$475,184
TOTAL costs for both cable types (14.1 circuit miles)	$5,912,303		$419,312

The protectors were installed, after which further switching tests were made to check that the devices were functioning as intended. During these tests one line at a time was switched, while the other three lines were energized and connected at both terminals. On the new tests, the protectors discharged during switching, indicating the presence of surges. The sheath insulators did not flash over, indicating that the protectors were functioning adequately. Klydonograph records indicated that the surge voltages were held to less than 5 kv from sheath to ground and to 7 kv across the sheath insulator. Discharges across the protectors were strong, but not violent. Where the covers of the protectors were loose, they were blown off the bases by the discharge. Where they were tight, they were only slightly loosened. An artificial fault to ground was established in one test on one phase at Mainwaring Substation with the complete 230-kv system interconnected and energized. No untoward demonstrations occurred at the protectors or else-

where. Following this series of tests, all protectors were examined for damages and checked to see that no gaps were short-circuited. All units were found to be in good order. It is believed the *118A* protectors have not been misapplied and that they will do an adequate job.

INSTALLATION AND COSTS

THE CABLE PULLING, jointing, and terminating of all four cable circuits was undertaken under contract by a cable installation contractor. Each cable supplier, however, was retained to supervise all phases of the installation of their respective cables.

Cable Pulling. To install the 1,900-foot cable lengths, a roller frame jig with horizontal and vertical rollers was set up in the expansion-bay manhole. The cables were pulled around this frame into their final trained position during the pulling operation. The roller frame was so designed that all three cables were installed with the one setup of the frame in the manhole. A stress of 10,000 psi on the copper conductor was set as the allowable limit for the pulling operation. For the 1,500-MCM British cable, therefore, maximum allowable pulling tension was 12,000 pounds. Friction coefficient reduction in the transite duct and the midlength offset was required if pulling tensions were not to exceed the set limit.

The outer cable serving was impregnated with graphite at the factory. To reduce the friction coefficient further during cable pulling, the inner surface of the duct was coated with graphite immediately prior to this operation. Friction coefficients varying from 0.2 to 0.3 were calculated from the actual observed pulling tensions. A 20-per-cent increase in friction occurred at the roller frame in the expansion manhole. During pulling, access to the cable was available at the anchor boxes and midlength expansion manhole, as well as at the feeding point. Men were stationed at all these points to apply additional graphite to the cable by hand.

For the 700-foot lengths installed on the Canadian circuits, the pulling tensions varied between 2,000 and 3,000 pounds for the majority of the lengths. Some offset duct sections were installed with 300-foot-radius curves. Because of the stiffness of the aluminum sheath, pulling tensions up to 4,500 pounds were recorded in these curved sections. Only flax soap was used on the cable as a pulling lubricant. No attempt was made to lubricate the ducts separately.

Anchor Clamps. In the British installation, the cable is anchored twice in each section length by clamps which are fitted in the concrete anchor boxes. As nonmagnetic materials are required, the clamps are cast brass with natural rubber liners cemented to the castings. The clamps, which are 42 inches long, are split longitudinally and twelve ½-inch bolts cinch the top and bottom clamp halves together. The bottom half of the castings has three sets of mounting feet to fasten the clamp securely to supporting steelwork in the anchor box. The clamp is intended to withstand a 2,000-pound thrust without movement of the cable.

Test After Installation. Following the completion of each line, a test after installation was made at 480 kv d-c for 15 minutes. The voltage is as prescribed in Paragraph 13.11 of the AEIC Specification, for 230-kv cable with 835-mil insulation. The d-c test apparatus is a portable set powered at 115 volts a-c and using capacitors and selenium rectifiers in a Cockcroft-Walton circuit[5] to produce the desired d-c voltage. The Vancouver set generates a maximum d-c voltage of 600 kv. Lower voltages are available if desired. During the tests, the d-c leakage current was normal and stable throughout. All tests were successful on the first trial.

Future Modifications. Additional 230-kv cable circuits are scheduled for installation within the next five years. Of several modifications planned for these lines, the most important will be the elimination of the expansion-bay manhole for the British cable. Duct sections will be 2,000 feet long, with a small manhole at the midpoint containing anchor clamps.

Costs. Over-all costs incurred on the entire project are given in Table II. Certain explanations are required to enable one to interpret these figures correctly. In order to meet the "in-service" schedule for these lines, overtime was authorized shortly after duct construction had started. Overtime charges increased the construction costs by approximately $200,000. The significantly higher duct costs for the Newell–Hill Avenue circuits reflect the construction conditions in the area. On these circuits the duct banks were not constructed on city streets but followed a 60-kv overhead circuit right of way across country. Access roads and extensive drainage ditches added approximately $35,000 to costs here. Subtracting these nonrepetitive costs from the total, it is estimated that future 230-kv duct lines could be built on city streets at an approximate cost of $120,000 per mile. This cost would be reduced by the modified duct layout proposed for future installations of the British cable design which has been discussed in the previous section.

The cable and accessories costs in Table II show a differential of less than 3 per cent between the reinforced lead sheath and the aluminum sheathed cables. However, on the present project the installation costs per mile for the aluminum sheathed cable were nearly double that of the reinforced lead sheathed cable. The additional splicing costs for the 700-foot cable lengths with aluminum sheath as compared to the 1,900-foot lengths for the lead sheath account for this difference in installation costs. This differential will be reduced on future lines because the Canadian supplier can now offer 1,050-foot lengths of aluminum sheated 230-kv cable.

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Electrical Service for Large Buildings

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A general procedure is outlined for solving problems of providing service to buildings involving loads of 500 kw or more.

THE PROBLEMS of supplying electrical service to loads that are 500 kilowatts (kw) or larger for office buildings and apartments basically are problems of economics and co-ordination. To solve these problems successfully, both from the customer's and the utility's viewpoint, requires co-operation between the consulting engineers for the customer, the engineers of the utility, and the local regulatory authorities.

When the consulting engineer has progressed to the point in his preliminary planning that he can supply the utility with the anticipated electrical load and the breakdown of this load into lighting, air conditioning, cooking and miscellaneous power with the size of the largest motor that he anticipates will be required, he must be given the class of electrical service that will be supplied by the utility before he can proceed with the detailed planning of the building's electrical system.

CLASS OF SERVICE

THERE ARE THREE CLASSES of service that will be generally considered for loads of this magnitude:

1. Three-phase, 4-wire, 120/208 volts with secondary network backup.
2. Three-phase, 4-wire, 265/460 volts with secondary network backup.
3. A combination of voltages, that is, 3-phase, 4-wire, 120/208 volts networked for lights and miscellaneous power with the air conditioning supplied from a 3-phase, 4-wire, 265/460 volt radial service.

For each class of service, consideration must be given to the requirements of the customer at the particular location in question, the other customers in the immediate area and the possible future use of the utility facilities from the future customer and the utility viewpoint.

In an isolated area, a 3-phase, 4-wire, 120/208-volt or a 3-phase, 4-wire, 265/460 volt class of service may be given. However, particular care must be exercised in considering the future development of the area. If the area involved is commercially zoned with small shops, the 265/460 volt class of service could impose a hardship on the small shop owner. If his utilization voltage was 120 or 208 volts, autotransformers would be required.

If the location is in an established low voltage, alternating current, secondary network area, the problem is somewhat different. To serve loads from a secondary network system economically, the transformers in the area must be relied upon for backup, to some extent, under normal and emergency conditions and the transformers installed for a particular load should provide capacity and backup to the area. If this procedure is not followed a duplication of plant will result in needless expense and eventually this will reflect in the rate base and in the bills of all the customers. For example, a proposed load of 1,000 kv amperes (kva) is to be added in a network area. Let us assume that the network could supply approximately 200 kva of backup under emergency conditions. This load could be supplied by the addition of two 750-kva network transformers at 120/208 volts inasmuch as the additional capacity that would be required with one of these transformers out of service is available from the existing network. The installation would require an expenditure for two transformers, two transformer manholes, and the associated conduit and cable. If a class of service of 265/460 volts was furnished, it would require a minimum of three 500-kva network transformers, three transformer manholes, and the connecting conduit and cable including the possible extension of a new primary feeder into the area for the additional transformer. The additional expenditure that would be required for the third transformer and manhole at present-day prices would amount to approximately $16,000.

If a proposed building is on the fringe of an established 120/208 volt network or in an area where the transformers are heavily loaded and little backup exists, a 265/460-volt class of service can be given without additional expense and would result in a saving to the customer for building wiring. After a 265/460-volt class of service is given, the area would then be considered as having the higher utilization voltage for all future planning.

A combination of the 120/208 and the 265/460-volt class of service can be given where the large air conditioning motor load is such that it will approximately load a transformer. In this case the 3-phase, 4-wire, 120/208-volt service is networked and would supply the lights and miscellaneous power, and the 3-phase, 4-wire, 265/460-volt radial class of service would be given for air conditioning only. The 460-volt radial service would sustain certain outages due to regular maintenance or fault conditions on the supply feeder. This would not be a serious inconvenience to the customer but merely cause personal discomfort for a reason-

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able length of time while work is performed on the primary supply. The consulting engineers would have to weigh the possibility of losing the air conditioning service against the possible reduction in cost of the large compressor motor and associated control equipment.

After the class of service has been determined, the interrupting duty that may be expected on the service equipment under fault conditions and the maximum allowable locked rotor starting current is calculated in the usual manner. This information is then given to the consultant.

SPACE REQUIREMENTS

To supply the consultant with the electrical characteristics of a proposed service, the physical characteristics of the installation must be considered.

In Washington, D. C., as in any large city, the public does not realize the tremendous amount of subsurface facilities that are installed to sustain our standard of living. An area 6 feet 10 inches wide by 44 feet 8 inches long is the probable minimum space required for the transformer installation to supply an office building. The length of the area is a result of design of the networks. Sufficient space is required on the primary end of the manholes for switching and the secondary end to service the protectors without removing the transformers. As a result of all the underground facilities, public space allocation has become a major problem to the local authorities and the utilities.

In the interest of conserving public space, the authorities have requested: (1) that a minimum of space be occupied perpendicular to the curb; (2) that installations be planned in such a way that they will interfere as little as possible with the vehicular and pedestrian traffic; and (3) that there will be no interference with future highway and sanitary facilities.

With the aforementioned and code requirements in mind, the preliminary building plans are obtained from the architect or consulting engineer as soon as they are available and a study is made to determine the feasibility of supplying the building at the location indicated on the plans.

The first step in this study is the plotting of the existing underground facilities on a scale drawing of the general area. The location of the existing facilities are obtained from records of the District of Columbia Government and other utilities. Superimposed upon the existing facilities are the proposed utility connections to supply the building as shown on the architect's plans. The layout is then checked for accuracy in the field.

The electrical layout is planned to ensure a minimum of conflict between all the facilities involved, to provide an equal distribution of load on the transformers, to maintain proper voltage regulation, to ensure a minimum of noise interference, to fulfill code and regulatory requirements, and to prevent future maintenance of the installation from interfering with the normal use of the building.

To fulfill these requirements, the plans of the building that are obtained from the architect must indicate the proposed entrances to the building, any projections on the building either subgrade or overhang, the elevations of basement, subbasement, and first floor. The plans should also include the proposed excavation plans, if they are available.

If there is a conflict of public space usage or clarification needed on the interpretation of plans, a meeting is arranged between the architect, consulting engineer for the building, and an engineer for the power company, and a compromise of plans is mutually agreed upon.

Perhaps, examples are the best way of indicating the need for early planning and co-ordination in working out a compromise when a major conflict is involved.

In one instance, the excavation for the building extended into public space and occupied the only available location for the necessary transformer manholes. After a discussion of the problem, it was agreed that the contractor would drive piles to support the manholes. This was a satisfactory solution for all concerned because it was more economical for the contractor to drive the piles to support the manholes than to decrease the size of his excavation by the use of steel sheeting to replace a sloping excavation.

In another instance, a building was planned with two basements that were to be used for parking facilities, extending into public space. In this case, it was agreed that a portion of the first basement would be omitted and the roof of the sub-basement reinforced to support the utilities.

These examples are exceptional cases but they do indicate the complications that may arise and the importance of close co-operation in the early planning stage.

After an agreement has been reached on the location of the proposed installation, a scale drawing is prepared and prints are submitted to the "Co-ordinator of Underground Locations" for the District of Columbia for space reservation.

The Co-ordinator circulates these prints within the various departments of the District to prevent any conflict between the use of the space indicated for the electrical facilities and the long-range plans of the District. If the plan meets the requirements of the District, it is approved and placed in file and no permit will be issued for the use of this space other than that indicated. Copies of the "space reservation" drawing are distributed to the other utilities and the consulting engineer and contractor for the proposed building. This plan has been very successful in preventing last minute problems in supplying service and conserving public space.

By allocating public space, all of the network transformers have been installed outside the buildings. As the congestion becomes more acute, it is anticipated that the customers will be required to provide the needed space within the buildings in the not too distant future.

SERVICE EQUIPMENT

THUS FAR, ONLY THE ELECTRICAL CHARACTERISTICS and the use of public space have been touched upon. Another problem that often is not considered early enough in the planning of a building is the details of the service equipment.

The electrical contractor must submit detailed plans of the proposed service equipment installation showing the arrangement of the service raceway, cable, and busses, beginning at the point of service entrance and ending at the current transformer compartment to secure approval in writing by the power company prior to fabrication of the equipment, if the service equipment is rated at more than 300 volts, is switchboard mounted, or has a rating totaling more than 1,200 amperes.

It is important that the plans be submitted for approval early enough to prevent delays in shipping and installation of the service equipment. It is equally important that the service connection be installed to conform physically with the service equipment. Unless the installation is in accordance with the approved plans, last minute delays and needless expense result.

SCHEDULING

FROM AN ECONOMIC VIEWPOINT, the scheduling of an installation of this size is an important factor from the utility's point of view. With the high "fixed charges" on capital that exist today, it is not difficult to understand why an installation should not be completed several months before it is needed. It is also important that the installation be completed in time to provide the service when it is required.

The construction of the electric facilities must be co-ordinated with the building contractor to prevent conflicts. Often, the building contractor will use the space to be occupied by the proposed utility installation for storage of materials. By using the "space reservation" drawing, the contractor can plan his material storage area in such a manner that the area will be clear to meet the utility construction schedule. With close co-ordination and realistic scheduling all parties concerned benefit.

The economic and co-ordination problems in providing service to large buildings that must be considered can be summarized as follows:

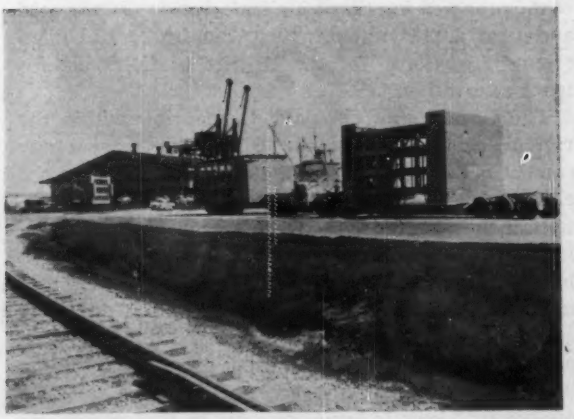
1. Supplying the most economical class of electrical service for the building after consideration has been given to the existing and future requirements of the area.

2. Co-ordinating the use of public space with the customer, utilities and local authorities to insure the issuance of a permit for construction.

3. Developing a detailed plan of the service equipment to prevent last minute delays.

4. Scheduling the job to provide service when it is required.

Huge Condensers Shipped Via Great Lakes



Shipping big condensers by way of Great Lakes freighters is not the usual method employed by Allis-Chalmers but the Milwaukee firm did just that recently.

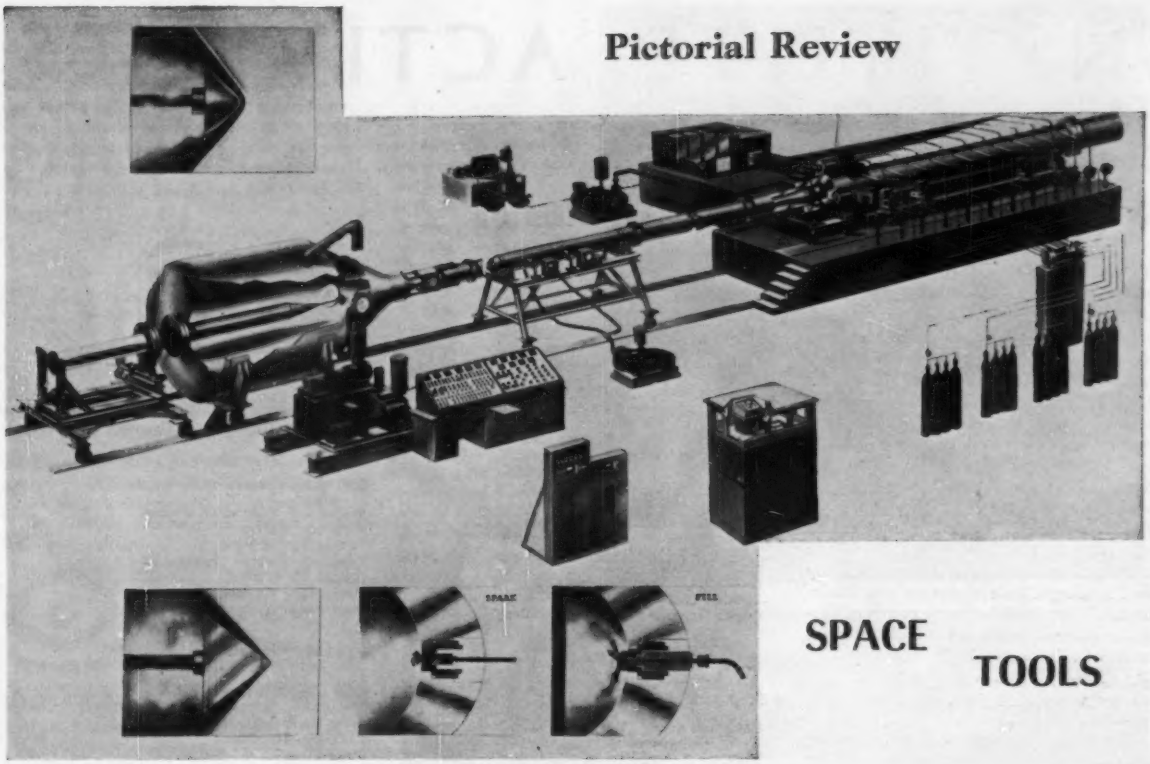
When Detroit Edison Company ordered two 170,000-square foot condensers, one each for units No. 5 and 6 at their St. Clair power plant, they specified that the exhaust neck be shipped in one piece. Inasmuch as this meant that the piece would be too big for rail shipment, the possibilities of lake shipment were then explored.

Finding lake shipment to be the answer for the neck piece, Allis-Chalmers decided to do the same with the shell. Because their engineers did not have to worry about railroad clearances, it was possible to fabricate the shell in three pieces rather than the usual four. This simplified field erection.

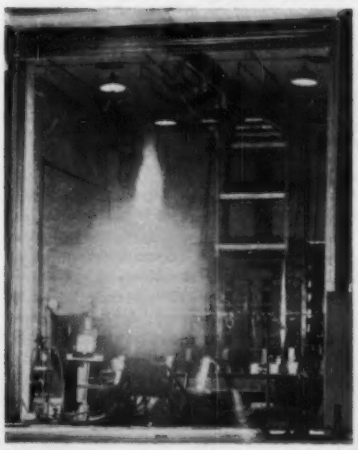
Slated to go into operation in early 1959, this condenser will work with a 320-mw turbine generator in unit No. 5. The other Allis-Chalmers condenser is scheduled to be supplied for Unit Number 6 early in 1961.

The pieces were trucked to Milwaukee's ship loading dock by four giant flatbed trailers and hoisted aboard the *S.S. W. C Richardson*. The lake freighter is owned by the Columbia Transportation Division, Oglebay Norton Company of Cleveland, Ohio.

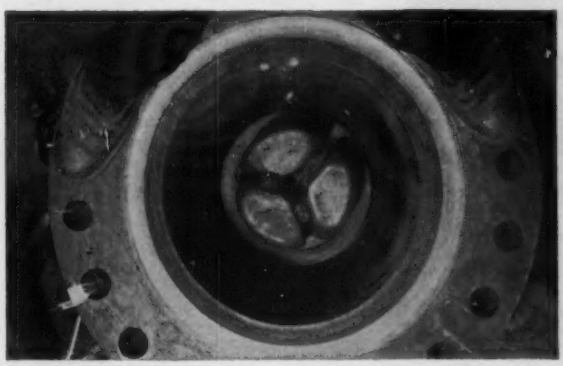
Approaching the port's record for size of material handled (in physical dimensions), one big shell section measured 26 feet long by 15 feet, 6 inches wide and 15 feet, 4 inches high.

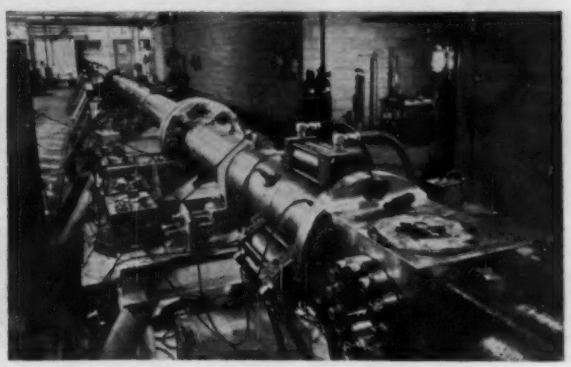


SPACE TOOLS



COMPLETE space technology shock tunnel operation *(above)*, in artists' rendering, shows major components—the driver tube at right filled with explosive mixture of gases (see inserts), highly instrumented driver tube portion down which hot high-speed air is propelled, and reservoir at left preceded by an expansion nozzle. Fuels, consoles, Schlieren system, and many other instruments round out the picture of General Electric Company's newest space technology tools in various department installations. These instruments were developed to help produce vehicles for outer space flight. Powerful stream of dissociated ultrahot air is discharged as plasma stream from large new plasma-jet generator *(left)*. Producing temperatures over twice sun surface temperature, this 3-phase a-c arc allows testing of comparatively large space flight models while simulating the heat and chemistry of atmospheric re-entry. Three electrodes, *(lower left)* variously shaped to help provide differences in plasma flow, are short circuited across to begin the run. The short circuiting material here is steel wool, but can be copper strip or other conductor, consumed immediately after the arc is struck. Air is forced tangentially along container wall from openings at base of electrodes. The rushing, sweeping air provides cooling effects and is itself basically the plasma raw material. Highly instrumented tube portion *(below right)* of tunnel ends in large reservoir that is not shown. Driver tube section is beyond doors. Expansion of hot gases gives aerothermodynamic information recorded by Schlieren and by many other methods. The artist's cutaway drawing of the shock tunnel gives a clearer picture.





INSTITUTE ACTIVITIES

"Renaissance City of America" Will Be Host to 1958 Fall General Meeting

PITTSBURGH is extending a warm welcome to all those who attend the 1958 Fall General Meeting of the Institute, beginning on Sunday, October 26, and extending through Friday, October 31. Headquarters for this meeting will be at the Hotel Penn-Sheraton. The hotels committee has room reservations in this and neighboring hotels for a maximum attendance. Members will find an early Fall visit to the "Renaissance City of America" an exhilarating experience.

Theme of the Fall Meeting is "Research —Gateway to the Future." Many of the activities are keyed to this theme and to the Pittsburgh Redevelopment and Bicentennial. There will be many events of particular interest to the ladies and the social activities will be ample for all.

Technical Sessions

The tentative program of technical sessions follows. (Titles of papers will be published later.)

Monday, October 27

9:00 a.m. Morning Sessions

Data Communications
Insulated Conductors
Nucleonic and Radiation Instruments
Management
Research
Electronics

2:00 p.m. General Session

Tuesday, October 28

9:00 a.m. Morning Sessions

Communication Switching Systems
Transmission and Distribution
Power Generation
Feedback Control Systems and Mining and Metal Industry
Industrial Power Systems
Safety

2:00 p.m. Afternoon Sessions

Transmission and Distribution
Metal Industry
Industrial Power Systems
Basic Sciences
Power Generation and Nucleonics

Wednesday, October 29

9:00 a.m. Morning Sessions

Communication Theory
Transmission and Distribution
Rotating Machinery and Relays
Metal Industry
Land Transportation
Nucleonics

2:00 p.m. Afternoon Sessions

Communication Theory
Rotating Machinery
Power System Communications
Metal Industry
Land Transportation
Computing Devices and System Engineering

Thursday, October 30

9:00 a.m. Morning Sessions

Radio Communication Systems
Rotating Machinery
System Engineering
Industrial Control
Magnetic Amplifiers
Computing Devices and Feedback Control Systems

2:00 p.m. Afternoon Sessions

Radio and Television Systems
Rotating Machinery
System Engineering
Feedback Control Systems
Industrial Control
Computing Devices
Semiconductor Metallic Rectifiers

Friday, October 31

9:00 a.m. Morning Sessions

Wire Communications Systems
Rotating Machinery
Transformers
Switchgear
Feedback Control Systems
Computing Devices
Solid-State Devices and Semiconductor Metallic Rectifiers

2:00 p.m. Afternoon Sessions

Rotating Machinery
Transformers
Switchgear
Feedback Control Systems
Computing Devices
Solid-State Devices

ON FRIDAY AFTERNOON, October 31, a special train will take visitors from the AIEE Fall General Meeting direct to the center of Conway Yard of the Pennsylvania Railroad, one of the world's largest and most modern freight car classification yards. Here automation is at work in the form of electronic analog computers, radar, automatic switching, inductive trainphone, cab signals, electronic scales, punched-card accounting machines, micro-talkie radios, intercom and paging systems, automatic floodlights, pneumatic tubes, teletypes, and tape recorders, in an integrated system to permit handling 9,000 cars per day.

Inspection Trips

During the Fall General Meeting there will be eight inspection trips of outstanding interest. These will include visits to centers of research, nuclear power development and application, and to interesting industrial operations. A list of these inspection trips follows.

Tuesday Morning—The Irwin Works of United States Steel Corporation will be visited. Here visitors may see many steel mill operations.

Tuesday Afternoon—A tour of the East Pittsburgh Plant of the Westinghouse Electric Corporation, which is the largest of the divisions of this corporation, will provide an opportunity to see the manufacture of the larger and heavier apparatus lines of the electrical industry.

Tuesday Afternoon—Another Westinghouse tour will be to their atomic power department which is devoted to the research, development, application, and manufacture of commercial nuclear power reactors. This visit includes the Reactor Evaluation Center where critical tests are being conducted on reactor core designs.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Attendance on this trip will be limited to 90 persons.

Wednesday Morning and Afternoon—In view of the interest which is expected to be shown, a full day will be devoted to visits to the Shippingport Atomic Power Station operated by the Duquesne Light Company.

Thursday Morning—Members will be taken to the United States Steel Corporation's Research Center at Monroeville, Pa. This is one of the largest laboratories for steel research in the free world.

Thursday Afternoon—Another research center to be visited is that of the Aluminum Corporation of America at New Kensington.

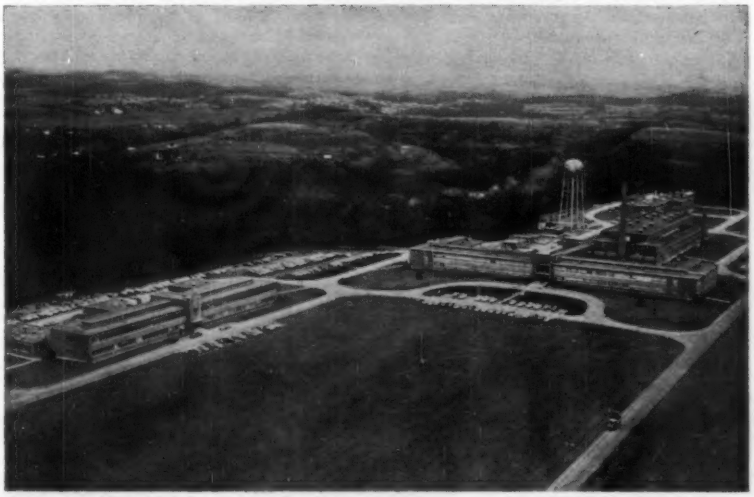
Friday Morning—Members will visit the Westinghouse Research Laboratory located in a country-like atmosphere 10 miles east of the heart of Pittsburgh.

Friday Afternoon—There will be a tour by special train to the Pennsylvania Railroad's Conway Yard. This is one of the world's largest and most modern fully-automatic freight car classification yards. Here will be demonstrated the Union Switch and Signal's VELAC Automatic Classification Yard System.

Committee

Members of the 1958 Fall General Meeting Committee are: A. A. Johnson, chairman; Dixon Lewis, vice-chairman; W. H. Osterle, secretary; A. P. Hayward, treasurer; E. L. Harder, program; F. H. Schlough, publicity; M. P. Getting, registration; C. N. Clark, hotels; E. M. Hays, inspection trips; G. H. Phillips, papers; Pascal Beckjord, hospitality; Mrs. Tomlinson Fort, ladies; E. S. Reeser, entertainment; E. M. Williams, student activities; W. R. Harris, Pittsburgh Section.

THE East Pittsburgh Plant, to be visited on Tuesday afternoon during the AIEE Fall General Meeting, is the largest of the Divisions of the Westinghouse Electric Corporation. Its six million square feet of floor space are devoted to the manufacture of the larger and heavier apparatus lines of the electrical industry. These include the largest of generators, oil circuit breakers, rectifiers, a-c and d-c motors, and a complete line of switchgear. The generator production aisle is shown at the right.



AERIAL VIEW of U. S. Steel's Research Center in Monroeville, Pa., which will be visited on Thursday morning, October 30, during the Fall General Meeting. There are now nearly 1,000 technical and scientific personnel engaged in fundamental and applied research here, making this one of the largest laboratories for steel research in the free world. Subjects under investigation include such widely diversified problems as new processes for up-grading coal chemicals and the study of dislocations in the atomic structure of steel.

Report on Satellites and Space Stations Among Features of NEC

An up-to-the-minute report on satellites and space stations and a discussion of automatic navigation will be featured at the 14th Annual National Electronics Conference (NEC) which will be held October 13-15, 1958, at the Hotel Sherman in Chicago, Ill.

In addition, there will be a panel discussion on "The Role of the Laboratory Program in Engineering Education" and a session with five journalists covering the subject of "Engineering Writing and Speech."

About 100 scientific papers, given by men from 16 states and 3 foreign countries, will include such topics as: antennas, audio, communications, computers, engineering management, industrial electronics, instrumentation, amplifiers, microwaves, radar and radio navigation, television, and transistors.

A record number of commercial exhibits, highlighted by displays of new electronic developments and devices, is scheduled. There will be social events and programs for wives of men attending.

NEC, as the nation's leading forum on electronic research, development, and application, expects to attract over 10,000 registrants, principally scientists, engineers, educators, manufacturers, and Government officials.

Sponsors of NEC are: AIEE, Illinois Institute of Technology, the Institute of Radio Engineers, and Illinois and Northwestern Universities. Participants are: Michigan, Michigan State, Notre Dame, Purdue, Wayne State, and Wisconsin Universities, Electronic Industries Association, and the Society of Motion Picture and Television Engineers.

Summer General Meeting and Air Transportation Conference Held

A FULL WEEK of technical and social activities was enjoyed by more than 2,000 members and guests at the AIEE Summer General Meeting and Air Transportation Conference, held June 22-27, 1958, at the Statler Hilton Hotel, Buffalo, N.Y. In addition to a varied technical program, numerous inspection trips and special events were planned.

The President's Reception and Banquet, held Thursday, June 26, featured the presentation of an Honorary Membership in AIEE to the Honorable Donald A. Quarles, Deputy Secretary of Defense. Texts of the presentation speech by President W. J. Barrett and the acceptance speech by Dr. Quarles may be found on pp. 787-90 of this issue.

Inspection trips were made to 12 nearby plants, including the Bethlehem Steel Company, Bell Aircraft Corporation, Huntley Steam Generation Station of the Niagara Mohawk Power Corporation, Cornell Aeronautical Laboratory, and New York Telephone Company.

Events for the ladies included a tour of the world-famous Kittinger Furniture Company in Buffalo, a tour of the General Mills cereal plant, and a fashion show and luncheon at the Rendezvous Room of the Statler Hilton Hotel.

General Session

The combined general session and annual meeting was called to order by D. J. Munhall, general chairman of the Summer General Meeting Committee. M. L. Rowley, chairman of the Niagara Frontier Section, and D. E. Garr, vice-president District No. 1, presented brief welcoming addresses.

Rob Roy MacLeod, vice-president, Niagara Mohawk Power Company, gave the principal address, "The Birthplace of Electric Power." He described the background of the Niagara Frontier area, and brought out many little-known facts about the region. He gave an interesting description of the Edward Dean Adams Station, which provided the first alternating current for system distribution in the United States.

The annual meeting was opened by AIEE President W. J. Barrett. The Treasurer's report for the fiscal year 1957-58 was summarized by L. F. Hickernell, AIEE treasurer.

The Treasurer reported that the total income for the year 1957-58 was $1,759,876, compared with $1,719,042 for the year 1956-57. Income from dues and fees increased $29,618 (3.3%); advertising decreased $23,650 (4.4%) because of curtailment in recruitment advertising; registration fees and conferences increased $15,601 (27.0%); and investment earnings increased $11,990 (30.9%). Total income increased $40,834 (2.4%).

A review of Institute accomplishments during the past year was presented by Mr. Barrett (see pp. 777-80 of this issue of *Electrical Engineering*).

He then introduced the officers-elect for the year 1958-59. These include *President:* L. F. Hickernell. *Vice-Presidents:* District No. 1, L. C. Holmes; District No. 3, J. R. Kerner; District No. 5, R. B. Gear; District No. 7, I. J. Monseth; District No. 9, J. M. Nelson; District No. 11, W. H. Chase; District No. 13, C. P. Nost. *Directors:* W. A. Lewis, E. C. Starr, N. F. Rode. *Treasurer:* C. H. Linder.

The introduction of officers-elect was followed by the induction ceremony for President-elect, Hickernell. In his brief response, Mr. Hickernell pointed out the tremendous increases in the cost of Institute operation during the 32 years in which he has served on various committees. In closing, he stated that he considered that being chosen for the presidency of AIEE is "the climax of an electrical engineer's professional career—of which one may dream, but hardly expect to attain."

The 30th annual award of the Lamme Medal was made to H. S. Black, Bell Telephone Laboratories, Inc. H. I. Romnes described the history of the medal, M. J. Kelley outlined the career of the medalist, and Mr. Barrett presented the medal to Mr. Black. The text of the presentation and response appeared in the August 1958 issue of *Electrical Engineering*, pp. 720-23.

The meeting concluded with the presentation of the Student Prize Papers Awards. The winners were as follows: District No. 1, M. W. Musbach, Union College; District No. 2, I. E. Sutherland, Carnegie Institute of Technology; District No. 3, Peter Hirsch, Polytechnic Institute of Brooklyn; District No. 4, Copthorne Macdonald, University of Kentucky; District No. 6, A. P. Wilson, South Dakota School of Mines and Technology; District No. 7, J. R. Cox, Texas A & M College; District No. 8, A. R. Wilson and R. A. Mintz, California State Polytechnic Institute; District No. 9, D. B. Ulm and Myron Hurlbut, Oregon State College; District No. 11, W. C. Susor, University of Toledo; and District No. 12, Robert Doyle, Northeastern University.

Photography by the Towne Studio

H. S. BLACK (left), of Bell Telephone Laboratories, Inc., receives the Lamme Medal from outgoing AIEE President W. J. Barrett *(right)* at the Annual Meeting during the 1958 Summer General Meeting of the Institute in Buffalo, N. Y.

Luncheons

Three luncheons were held during the meeting. The first, on Tuesday, June 24, commemorated the first commercial use of alternating current and the other two, held on Wednesday, June 25, and Thursday, June 26, were particularly appropriate in conjunction with the Air Transportation Conference.

To commemorate the first alternating current installation which was installed in the department store of Adam, Meldrum & Anderson in November 1886, a plaque was presented by the Niagara Frontier Section of AIEE to Robert Adam, president of the firm. The presentation was made by A. C. Monteith, past president AIEE, and vice-president of the Westinghouse Electric Corporation. He presented a colorful story of early electrical history including an account of how George Westinghouse induced and backed William Stanley to develop the alternating current system and the transformer. This development and the free private enterprise system did more to raise the standard of American living as known today than any other single development.

Featured at the second luncheon was an address by Leston Faneuf, president of the Bell Aircraft Corporation, entitled "Electrical Frontiers in Space." The

speaker referred to the creation of Avionics Divisions in the various aircraft companies and the number of scientific breakthroughs that have occurred in the past two decades brought about by the union of aviation and electronics as exemplified distinctly in the field of guided missiles in the coming space age. The joint efforts of several companies combined as a team in development were exemplified by the Martin Bell team which is sharing with the Boeing team the first phase responsibility for the DINA-SOAR Program. Also associated with the project are Bendix, Minneapolis-Honeywell, and Goodyear Aircraft in electronics capacities. The full text of the address will appear in a subsequent issue of *Electrical Engineering*.

The third luncheon was addressed by Major General M. C. Demler, Air Research and Development Command. With a forward look, General Demler outlined some of the problems to be solved in the area of electric power for future flight vehicles; he stressed reliability as essential for space flight. He said that with the advent of the space age, electric power is assuming a role of primary importance. Once the main power plants have launched the satellite or space vehicle, secondary power becomes primary in supplying the energy for instrumentation and habitation as well as the propulsive power where this may be required. The need for significant advancements in the state of the art necessitates that both the industry and the Air Force pursue a vigorous program leading to attainment of these advancements. Full text of the address will be published in a subsequent issue.

Photography by the Towne Studio

A. C. MONTEITH, past president of AIEE *(second from left)*, presents plaque to Robert Adam *(second from right)*, president of Adam, Meldrum & Anderson, Buffalo, N. Y., to commemorate the first alternating current installation which was installed in the firm's department store in November 1886. Also at the presentation which took place during the AIEE Summer General Meeting, were W. J. Barrett *(left)*, 1957-58 president of AIEE, and M. L. Rowley *(right)*, chairman, Niagara Frontier Section.

Technical Sessions

Power Generation. A Monday morning session on power generation opened with a paper by W. D. Small of the Hydro-Electric Power Commission of Ontario, covering the electrical features of the Sir Adam Beck–Niagara station. The purpose of this pumping–generating station is to store the surplus, ordinarily wasted mechanical energy available at night and to turn it to use in meeting daytime peak demands for electric power.

The features of a new power project on the upper portion of New York State's Raquette River were described in a paper by W. C. Van Dyke of the Niagara Mohawk Power Corporation. The energy produced by the five generating stations is fed into the Niagara Mohawk 115-kv statewide transmission system at Colton, N.Y., the site of an existing major switching station.

The results of friction and windage loss tests on the 73,684-kva 85.7-rpm units at McNary Dam were detailed in a paper by D. R. Cox and R. L. Krahn, both of the U.S. Army Corps of Engineers.

The Kelsey hydroelectric development, located on the Nelson River in the Province of Manitoba, Canada, was described by L. M. Hovey of The Manitoba Hydro-Electric Board. The development is the first to be carried out on this river and was authorized in late 1956 for the purpose of supplying a 102-mw block of power to the International Nickel Company of Canada Limited, for operation of the new mine and smelter in the Mystery–Moak Lake area.

Radio Communications and Radar Interference. The scatter propagation mechanism has placed a new tool in the hands of the communication engineer. Long spans with great reliability have become feasible and a supporting technology of high-powered transmitters, huge antennas, and multiple receivers is available. C. A. Parry, Page Communications Engineers, Inc., Washington, D. C., discussed the factors which influence the use of multichannel scatter links, particularly in relation to national telecommunication network planning. Scatter is a specialized technique, he noted, and each individual possibility has to be examined on its own merit. His paper was entitled "Factors Affecting the Use of Over-the-Horizon Links in Telecommunication Networks."

L. P. Yeh, Westinghouse Electric Corporation, Baltimore, Md., attempted, in his paper, "Tropospheric Scatter System Design," a comprehensive procedure, from a partly experimental and partly theoretical approach, for the design of tropospheric scatter communication systems using single sideband or frequency modulation and frequency division multiplex (FDM).

Companion papers were "Radar Interference to Microwave Communication Services," R. D. Campbell, American Telephone and Telegraph Co., and "Design Characteristics of Some Existing Canadian Communication Systems Using Scatter Propagation," H. J. von Baeyer, Royal Canadian Air Force, and F. M. Banks, Bell Telephone Co. of Canada.

Mobile Radio Systems. Five papers were presented at a session devoted to various types of mobile radio systems and equipment. C. R. Kraus, Bell Telephone Company of Pennsylvania, presented a paper on "City-Wide Personal Signaling at Allentown–Bethlehem, Pa." This paper is scheduled for publication as an article in an early issue of *Electrical Engineering*.

J. W. Young described and demonstrated the Pagemaster system, a development of the Stromberg-Carlson Company. It is an industrial paging system which accommodates 455 receivers. The same principles can be extended into a system capable of servicing 3,235 individual subscribers and, therefore, would be adaptable to city-wide paging systems.

A conference paper presented by Walter Strack of Bell Telephone Laboratories covers a number of the problems associated with the evaluation and planning of one-way selective signaling systems operating in either the 35- or 150-mc range which might be used to provide city-wide coverage. The major areas considered are the pocket receiver, the radio transmission path, and the central office facilities.

Other papers included "An Integrated Mobile Microwave Communications System for the Massachusetts Turnpike," by R. F. Lowe of the General Electric Company, and "VHF Transistorized Pocket Receivers for Personal Communication and Paging Services," by G. A. Robertson of the Radio Corporation of America.

Industrial Control. Increased use of alternating current as the principal source of power on shipboard, and in aircraft and missiles has spurred the development of reliable sources of a-c power, D. W. Drews, Westinghouse Electric Corporation, reported in his paper "Static Exciters and Voltage Regulators for Portable Alternators." Not only must these sources be simple, light-weight, and rugged, he pointed out, but also precise with fast and accurate voltage regulation. In addition, they should require a minimum of maintenance and represent the utmost in reliability. The substitution of the static exciter and electromechanical regulator achieves all of these objectives and results in a compact, portable source of alternating current that has many industrial, commercial, and military applications.

A. T. Bacheler, Westinghouse Electric Corporation, discussing the emergence of the adjustable frequency synchronous drive into more general use, emphasized the problem of selecting adequate and economical synchronized drive systems. Until recently, he said, the Synchrotie system was used almost exclusively for synchronized power drives in such applications as glass bottle making machines, conveyors, paper coaters, wire insulating and serving machines, rubber calendar auxiliary drives and textile processing equipment. However, the present availability of reluctance type synchronous motors of high efficiency and acceptable power factor makes the adjustable frequency synchronous drive economically attractive.

A companion paper was "Temperature of Conducting Ribbon Magnet Coils," J. F. H. Douglas, Marquette University.

Rapid Transit. J. G. Inglis of the Toronto Transit System presided at a Tuesday afternoon session on rapid transit sponsored by the Land Transportation Committee. E. W. Ames, Westinghouse Electric Corporation, described a recently developed battery-charging voltage-regulator system using semiconductors. The system utilizes three semiconductors to control a low-voltage d-c generator. Three of the regulators have been installed in the New York City Transit Authority subway cars.

A paper presented by G. R. Purifoy of Westinghouse outlines progress in control design for rapid transit subway cars. Today's trend is toward simplification and light weight, resulting in less operating cost, and toward high reliability and reduced maintenance. In latest designs, special attention and consideration have been given to noninflammable insulation, protection from dust accumulation, long life, interchangeability of wearing parts, and economical maintenance.

The last paper at the session, by E. J. Hogan and J. C. Price of the General Electric Company, discussed the effects of high-performance rapid-transit cars upon traction substations.

Space Vehicles, Satellites, and Missiles. A highlight of the Summer General Meeting was the Tuesday evening panel discussion of problems in the control and instrumentation of space vehicles, satellites, and missiles. Sponsored by the Feedback Control Systems Committee and organized by moderator D. Herr of Librascope, the panel brought together scientific and engineering leaders from industrial and university laboratories in a stimulating three-hour discussion of the problems in this exciting forefront of engineering technology. A barrage of questions from 400 enthusiastic listeners who jammed the meeting room peppered the discussion.

After the opening remarks by L. F. Hickernell, president-elect of the AIEE, the seven panelists presented prepared remarks highlighting the nature of the engineering problems involved in space control. Dr. Levitt, astronomer of the Franklin Institute, indicated the nature of the underlying space mechanics and the accuracies required in satellite and space vehicle control. Dr. C. W. Draper of the Massachusetts Institute of Technology described the broad characteristics of the associated control and instrumentation problems and R. E. Hanna of Douglas Aircraft Company emphasized the control system design problems associated with such vehicles.

The specific problem of attitude control of satellites and space vehicles was treated in depth by the following three panelists: J. S. Farrior of the U. S. Army Ballistic Missile Agency (ABMA), R. E. Roberson of North American Aviation, Inc., and E. V. Stearns of Lockheed Missile Systems Division. The latter two considered inertial and aerodynamic stabilization in detail. The panel concluded with a discussion of component and system design considerations in terms of weight, volume, accuracy, and reliability by J. L. Bowers of Convair-Astronautics.

The panelists succeeded admirably in indicating the fundamental problems of control in space and the manner in which these problems differ from conventional control problems as a result of the different gravitational field, the changed environment, and the requirements of low power consumption and reliability.

Aircraft—Ground Support and Lighting. The first paper given at a Wednesday morning session sponsored by the Air Transportation Committee was "Ground Electrical Power Support" by C. B. Graff, Wright Air Development Center, and Maj. H. H. Barton, Air Research and Development Command. The requirements for missile applications in the near future are for large quantities of power up to 50,000 kw at each site. These power requirements are coming when a diminishing production of conventional fuels is predicted. Much work has been done with nuclear energy, which appears to have a promising future in this application.

A paper by E. L. Clark and A. J. DiStio, Beech Aircraft Corporation, covers an aircraft electric power system analyzer which permits relatively unskilled technicians to analyze and trouble-shoot present complex power sources and circuits efficiently.

The development of dimmable aircraft fluorescent lighting systems for the Douglas *DC-8* commercial jet airliner was described by E. W. Banios of the Ramo-Wooldridge Corporation. Two systems were designed: one for the cabin with a maximum lamp current of 150 milliamperes and an extremely high dimming ratio, and one for the cockpit with a maximum current of 200 milliamperes and a moderate dimming ratio.

System Economics. The economic integration of hydroelectric and steam plants in delivering required bulk power to a high-voltage transmission system was the subject of a paper by R. N. Brudenell and J. H. Gilbreath entitled "Economic Complementary Operation of Hydro Storage and Steam Power in the Integrated TVA System." The authors point out that the larger part of hydroelectric generation on this system comes from water storable at tributary multiple-purpose projects and, therefore, controllable over periods of many months under certain unique restrictions relating mainly to flood control. Because of these conditions, the hydroelectric generation can be treated as an entity and not as many unrelated, diverse pieces representing each plant. The paper, it was noted, was restricted to this seasonal type of integrated storage. The paper was divided into two parts: Part I discussed the general theory of the economic operation of steam energy with storable hydroelectric power, and Part II discussed the application of the principles developed to the operation of the integrated TVA system of dams and steam plants.

A. J. Wood, General Electric Company, read a paper on "Power System Planning Economics" which discussed the place of economic evaluation in power system planning.

Other papers presented were the "Economic Operation of Variable Head Hydro Plants," A. F. Glimn and L. K. Kirchmayer, General Electric Company; "The Calculation of Incremental Transmission Losses and the General Transmission Loss Equation," R. E. Watson and W. O. Stadlin, Leeds & Northrup Co.

Photography by the Towne Studio

SCIENTIFIC and engineering leaders from industrial and university laboratories presented a stimulating discussion during one of the highlights of the AIEE Summer General Meeting technical program—the session on space vehicles, satellites, and missiles.

AIEE Future Meetings

AIEE-NEMA National Electrical Insulation Conference*
Pick-Carter Hotel
Cleveland, Ohio
September 3-5, 1958

Fifth UPADI Convention
Queen Elizabeth Hotel
Montreal, Que., Canada
September 2-6, 1958

World Power Conference Sectional Meeting
Queen Elizabeth Hotel
Montreal, Que., Canada
September 7-11, 1958

Petroleum Industry Conference*
Baker Hotel
Dallas, Texas
September 15-17, 1958

Power Industry Computer Application Conference*
King Edward Hotel
Toronto, Ont., Canada
September 15-17, 1958

AIEE-IRE Industrial Electronics Conference*
Park Shelton Hotel
Rackham Memorial Auditorium
Detroit, Mich.
September 24-25, 1958

AIEE-ASME National Power Conference*
Statler Hotel
Boston, Mass.
September 29-October 1, 1958

26th Annual Meeting of ECPD
Sheraton-Jefferson Hotel
St. Louis, Mo.
October 9-10, 1958

AIEE-IRE-EIA-SMPTE National Electronics Conference*
Hotel Sherman
Chicago, Ill.
October 13-15, 1958

Machine Tools Conference*
Statler Hotel
Hartford, Conn.
October 13-15, 1958

Farm Electrification Conference*
Monteleone Hotel
New Orleans, La.
October 20-22, 1958

Fall General Meeting*
Penn-Sheraton Hotel
Pittsburgh, Pa.
October 26-31, 1958

Fall Textile Conference*
North Carolina State College
Raleigh, N. C.
October 30-31, 1958

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference
Pick-Nicollet Hotel
Minneapolis, Minn.
November 19-21, 1958
(Final date for †TP—closed, ‡CP Syn.—Sept. 5, CPMs—Sept. 15)

Magnetism and Magnetic Materials Conference
Sheraton Hotel
Philadelphia, Pa.
November 17-20, 1958
(Final date for †TP—closed, ‡CP Syn.—Sept. 3, CPMs—Sept. 12)

AIEE-IRE-ACM Eastern Joint Computer Conference (Exhibit)
Bellevue-Stratford Hotel
Philadelphia, Pa.
December 3-5, 1958
(Final date for †TP—Sept. 4, ‡CP Syn.—Sept 19, CPMs—Sept. 29)

AIEE-IRE Second National Symposium on Communication Systems (Exhibit)
Colonial Inn-Desert Ranch
St. Petersburg, Fla.
December 3-5, 1958
(Final date for †TP—Sept. 4, ‡CP Syn.—Sept. 19, CPMs—Sept. 29)

AIEE-IRE-ASQC-EIA National Symposium on Reliability and Quality Control
Bellevue-Stratford Hotel
Philadelphia, Pa.
January 12-14, 1959
(Final date for †TP—Oct. 14, ‡CP Syn.—Oct. 29, CPMs—Nov. 7)

Winter General Meeting
Statler Hotel
New York, N. Y.
February 1-6, 1959
(Final date for †TP—Nov. 3, ‡CP Syn.—Nov. 18, CPMs—Nov. 28)

AIEE-IRE-U of P Transistor and Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 12-13, 1959
(Final date for †TP—Nov. 13, ‡CP Syn.—Nov. 28, CPMs—Dec. 9)

AIEE-IRE-ACM Western Joint Computer Conference
Fairmont Hotel
San Francisco, Calif.
March 3-5, 1959
(Final date for †TP—Dec. 3, ‡CP Syn.—Dec. 19, CPMs—Dec. 29)

EJC Nuclear Congress
Cleveland, Ohio
April 5-10, 1959
(Final date for †TP—Nov. 28)

South East-South Central District Meeting
Dinkler Plaza Hotel
Atlanta, Ga.
April 8-10, 1959
(Final date for †TP—Jan. 8, DPMs—Feb. 2)

Electric Heating Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
April 14-15, 1959
(Final date for †TP—Jan. 14, ‡CP Syn.—Jan. 30, CPMs—Feb. 9)

Electrical Problems in the Cement Industry Conference
Allentown, Pa.
April 16-17, 1959
(Final date for †TP—Jan. 16, ‡CP Syn.—Jan. 30, CPMs—Feb. 10)

East Central District Meeting
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, DPMs—Feb. 16)

Rubber and Plastics Conference
Sheraton-Mayflower Hotel
Akron, Ohio
April 22-24, 1959
(Final date for †TP—Jan. 22, ‡CP Syn.—Feb. 6, CPMs—Feb. 16)

Empire District Meeting
Hotel Syracuse
Syracuse, N. Y.
April 29-May 1, 1959
(Final date for †TP—Jan. 29, DPMs—Feb. 20)

AIEE-IRE-EIA-WCEMA Joint Electronic Components Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
May 6-8, 1959
(Final date for †TP—Feb. 5, ‡CP Syn.—Feb. 20, CPMs—March 2)

Middle Eastern District Meeting
Lord Baltimore Hotel
Baltimore, Md.
May 19-21, 1959
(Final date for †TP—Feb. 18, DPMs—March 13)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Authors Guide*. For a copy, write to E. C. Day, AIEE, 33 W. 39th St., New York 18, N.Y.

Air Transportation—General Interest. The requirement for compact reliable warning systems in modern manned aircraft has given rise to a number of designs. W. Silbert of The Martin Company, Baltimore, Md., discussed the basic requirements of such designs in his paper "A Transistorized Warning Light System for Aircraft" and showed how reliability can be increased by a drastic reduction in the number of active circuit elements utilized. Circuits were shown employing transistors which enable the use of the standard 28 volt d-c aircraft power supply. Three different configurations were discussed: monostable multivibrator, bistable multivibrator, and regenerative switch. Each of these permits the use of a small invariant number of active elements regardless of the number of signals to be sensed.

P. W. Franklin, Leland Electric Co., dealt with the subject "On the Art of Specification Writing." The author attempted a definition of the essential characteristics of a desirable specification and discussed certain shortcomings and pitfalls often encountered. He defined a specification as a description of an expected performance and often an obligation to be fulfilled for financial returns, in view of which the exactness of definition is of particular importance.

M. A. Slavin of the General Electric Company described new, superior, pneumatically driven electric power systems based on the use of a recently developed "turbonator" and capable of operating in the high-temperature environment created by flights of high-speed aircraft.

Computers in Air Traffic Control. Three conference papers were featured at a Wednesday afternoon session sponsored by the Computing Devices Committee. G. B. Harwell of the Civil Aeronautics Administration (CAA) described techniques used for programming a computer system to process automatically the flight plans received at the Indianapolis Route Traffic Control Center. In addition to an input routine which conditions the flight plans for processing, there is a routine for processing flights that will be flown over designated airways and one for processing flights that will be flown by direct routes between specified points.

A paper presented by R. A. Finkler of General Precision Laboratory, Inc., discusses computer and programming techniques used in the Airways Modernization Board data processing and display technical program.

"Air Traffic Control Simulation Program" by K. W. Kowalka, H. R. Landow, and D. C. Lancto, all of International Business Machines Corporation, outlined a program which provided a model of the en route control functions of any Air Route Traffic Control center in the airway system presently operated by the CAA. Major functions simulated include entry of aircraft into and progress through the system, the filing of position reports, the detection and resolution of conflicts, and the transfer of responsibility from one control facility to another.

Transmission and Distribution. One of four sessions sponsored by the Transmission and Distribution Committee was held on Thursday morning, with H. A. Frey, General Electric Company, presiding.

Because of the high lightning outage rates being experienced on high-voltage transmission lines, a re-examination of the physical nature of lightning has been made. The investigation was reported in a paper "The Prestrike Theory and Other Effects in the Lightning Stroke" by S. B. Griscom of the Westinghouse Electric Corporation. In a companion paper by Mr. Griscom, J. W. Skooglund, and A. R. Hileman, the results of an analysis of the prestrike voltages and currents are presented.

The problem of anomalous flashovers was discussed by P. W. Shill of H. G. Akers & Company Ltd., Niagara Falls, Ont. Among the conditions which may have a bearing on this type of flashovers are the increase in dynamic voltage stresses across the critical insulation in a string, the possibility of faulty insulator units in the string, switching surges from distant points on a widespread network, and chopping of the current wave.

P. L. Bellaschi, consulting engineer of Portland, Oreg., outlined some of the insulation requirements of high-voltage transmission lines. The information covered relates to part of the over-all effort made during the past 8 years to rationalize the insulation of transmission lines in relation to actual service requirements.

Aircraft—Missiles, Satellites, Asteroids. Some recently announced electrochemical sources of secondary power for satellites and high-altitude missiles may soon replace monofuel turbines, H. Oman, Boeing Airplane Co., reported in his paper "New Sources of Secondary Power for Satellites and Missiles." The author said that although electrochemical systems are presently heavier in general than monofuel turbines, breakthroughs in gas-activated batteries and fuel cells have opened new opportunities for electrochemical systems.

The problem of accessory power supply for long-range rocket and satellite vehicles was expanded upon by K. L. Niebauer, Boeing Airplane Co. He reported that silicon solar cells can be used at extremely high altitudes and in space without experiencing damaging temperatures.

R. G. Leiby, Headquarters, Wright Air Development Center, Air Research & Development Command, United States Air Force, reported on "Unconventional Electric Power Supplies and the Weapon System." Although unconventional electric energy conversion is still in its infancy and efficiencies are low in many cases, the author noted that the increase in power to weight ratio and the absence of moving parts far outweigh efficiency considerations. The general purpose of the paper, he said, is to stimulate consideration of the place of these unique power supplies in the vehicle system.

A companion paper was presented by W. A. Tynan, The Johns Hopkins University, on "Application of Reserve Batteries in Missiles."

Solid-State Devices. A. E. Maine of The de Havilland Aircraft Company of Canada opened a session on solid-state devices with a paper on magnetic frequency dividers, prepared in collaboration with B. W. Glover of General Electric Company Ltd., Stanmore, England. The complicated mechanics of some of the divider systems were presented by means of simplified physical descriptions and graphical constructions of wave patterns.

"Stabilized breakdown," a nondestructive, essentially reversible phenomenon in selenium rectifiers was discussed in a paper by A. C. English of the University of California and W. H. Tobin of the General Electric Company.

A paper presented by R. H. Hurley described an analytical approach to stability criteria that indicates, at least approximately, whether or not a particular circuit, transistor, and set of operating conditions are likely to result in thermal runaway.

Photography by the Towne Studio

D. J. MUNHALL *(center)*, general chairman of the 1958 AIEE Summer General Meeting Committee, discusses meeting business with outgoing Institute President W. J. Barrett *(left)* and President-elect L. F. Hickernell *(right)*.

Transformers. W. W. Orr, Canadian General Electric Co., presented a paper on "Aluminum and Its Future in Power Transformers." The shortage of copper in the early 1940's brought about the use of aluminum in power transformer windings as a means of conserving copper, the author pointed out. He showed how the characteristics and cost of power transformers compare when using either aluminum or copper in their windings, and presented conclusions on the future use of aluminum for this purpose.

E. W. Manning, General Electric Company, reported on "The T-Connected 3-Phase Transformer." He suggested a means of building 3-phase transformers using standard single-phase parts. The characteristics were discussed and compared with conventional 3-phase transformers. Pertinent conclusions were drawn.

Switchgear. The use of sulfur-hexafluoride (SF_6) gas as an efficient interrupting medium for use in breakers of all ratings from low to high voltage and low to high kva was discussed by R. E. Friedrich and G. Bates, Westinghouse Electric Corporation. Its use offers a number of attractive possibilities, they pointed out. These include reduced maintenance and operating cost, negligible foundation shock, and, hence, minimum foundation structure, elimination of expensive auxiliary oil or air handling equipment, minimum number of breaks, relative insensitivity to rate-of-rise of recovery voltage, and excellent performance on capacitor switching and fault interrupting operations.

P. Barkan and E. J. Tuohy, General Electric Company, presented "The Effect of Linkage Flexibility on Dynamics of High Capacity Outdoor Circuit Breakers."

Television and Aural Broadcasting Systems. Seven conference papers were presented at the two sessions sponsored by the Television and Aural Broadcasting Systems Committee. The subjects covered included television broadcast problems, transistorization of a television receiver, techniques used in live color broadcasting, and a new image orthicon color camera.

One of the more interesting papers, "Chroma-Key Color Inset System" by F. Gaskins and R. Kennedy, National Broadcasting Co., described how an actor could be made to appear against any type of background in a studio by the use of two color cameras and a switch operating at an approximate rate of 0.1 microsecond.

The background scene in tones of blue-green painted on an 18- by 24-inch screen is picked up by one color camera. The color of the actor's clothes and his flesh tones are reddish-yellow and he is posed before a blank background of a certain shade of blue. By means of the ultrafast-acting switch and gating pulses, the outputs of the two color cameras are mixed so that the color of the plain background of the actor is not picked up by the second camera and he appears superimposed on the bluish miniature scene.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. Members may receive one subscription to any *one* of the bimonthlies for $2.50. The balance of the annual $5.00 subscription price will be paid by application of his annual dues for the year of the subscription. (Members may not reduce the amount of their dues payment by reason of nonsubscription.) Additional member subscriptions will be at the rate of $5.00. Nonmembers may subscribe on an advance annual subscription basis of $8.00 each (plus 50¢ extra for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.50 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Forum of Technical Committee Chairmen Is Conducted on a Group Dynamics Basis

THE 18TH FORUM of Technical Committee Chairmen held on Wednesday evening during AIEE's Summer General Meeting, was called to order by Hendley Blackmon, chairman of the Technical Operations Department (TOD). Past-President W. J. Barrett, who had addressed the forum on several previous occasions, gave a cordial welcome, and, after the presentation of two valuable papers on operational procedures, the meeting was turned over to Dixon Lewis, past chairman of the Sections Committee, who introduced a group dynamics discussion. This type of meeting has met with considerable success in a number of the Sections.

How To Improve Conduct of Sessions

Valuable suggestions to improve the conduct of technical sessions were given to the chairmen of technical committees and presiding officers by C. T. Hatcher, vice-chairman, TOD. Familiarization with the contents of the technical sessions guide by every chairman was strongly stressed. It was stated that authors should take advantage of communication theory by not reading from their papers when making presentations and an editorial to this effect which appeared in the April 16, 1958, issue of *Electronic Design* was brought to attention. In this respect, chairmen should convey to the authors the idea that they cannot possibly read their entire papers in the allotted time; therefore, the presentation should be as concise and emphatic as possible to hold the attention of the audience. For the guidance of chairmen, the following five points were summarized: (1) make sure that all of the mechanical devices are available, such as projectors, slides, screen, and so forth; (2) make the speaker feel comfortable and at ease; (3) provide a good introduction of the speaker; (4) see that the time schedule is maintained; and (5) attempt to generate and organize a good discussion period.

Check Chart for Committee Chairmen

Key points for technical committee chairmen to bring out the best leadership in a voluntary organization were presented by Chairman Blackmon in a convenient check chart form. The main purpose of the check chart was to stimulate advanced thinking in the areas of background, planning, organization, and operating efficiency. The five functions of technical committee chairmen and the five aids to accomplishment of objectives as outlined by Past-President Barrett in the Forum last Fall and published in *Electrical Engineering,* December 1957, p. 1088, were brought to attention.

Group Dynamics Discussion

The assemblage was arranged in groups of eight, a chairman of each group appointed, and after 10 minutes' deliberation, seven groups came up with the following questions written on the blackboard by Dixon Lewis. The questions, answered by officers and members of the headquarters staff designated by the chairman to respond, were:

1. How can a chairman promote interest of his committee in Section activities?
2. How should a chairman of a new committee select personnel so as to be sure of getting the best members for the work?
3. How can the quality of papers be improved without turning down good contributions?
4. How can a chairman get authors to abide by a 15-minute time limitation for presentation?
5. Can the Institute reorganize its meetings to obtain fewer parallel sessions?
6. What consideration was given to the raising of the prices for the bimonthly publications?
7. Why not appoint technical committees to serve for a two-year period with half of the members appointed each year?

With the objective to have fun and provide greater participation, further suggestions arose from a second buzz session. One suggestion was to limit the Forum to a two-hour meeting and have the chairmen bring questions to the meetings in advance. The criticism was made that there were too many formal presentations and a tendency to have the old timers answer the questions. Another suggestion involved having the officers in a panel to answer the questions and still another to have the staff of the Institute describe their jobs. Dixon Lewis concluded that more people had participated in the meeting than heretofore—one of the objectives of the group dynamics method. Many favorable views were expressed in regard to the liveliness of the meeting.

Prize Rules for AIEE Papers

THE FOLLOWING are rules for the award of prizes for AIEE Papers which were approved by the Board of Directors on June 28, 1956, superseding those previously in effect.

General Information

In order to recognize and promote the contribution of meritorious papers, the AIEE has established a series of prizes which are available for annual award to members for outstanding papers. All awards are optional, not obligatory, and it is expected that discriminating judgment will be made by each responsible committee. Each prize consists of a sum of money and/or a Certificate of Award. Appropriate recognition will be given in *Electrical Engineering* and the AIEE "Year Book."

Prizes are available on the national level, known as Institute prizes; on the District level; on the Section level; and on the Branch or Undergraduate level.

To be eligible for an award, a paper must have been presented at a qualified technical meeting of the AIEE (Winter, Summer, Fall, or Pacific General Meeting; District Meeting; Special Technical Conference; Section, technical group, or Subsection Meeting; or Branch Meeting), except as provided in section (*b*) under Institute Prizes.

Any monetary prize will be divided between coauthors and each will receive a certificate. Certificates and checks for awards are prepared at Headquarters under the cognizance of the Prize Awards Committee. An equivalent gift may be substituted for the monetary prize.

To be eligible for any awards, the author, or at least one coauthor, of a paper must be a member (any grade) of the Institute and the other coauthors must be members of a professional society of comparable standing. District, Section, and Branch prizes will be limited to papers, one of whose authors is resident or employed within the respective territory. AIEE committee and subcommittee reports are not eligible for prizes.

All prizes will be awarded on the basis of papers presented during the administrative year, nominally August 1 to July 31, except as specifically stated within these rules. The technical excellence of the paper and its value in its field should constitute the primary basis of awarding of prizes rather than the numerical grades assigned by the original reviewers.

Prizes based on competitive presentation may be withheld whenever, in the opinion of the responsible committee, the number of papers is not sufficient to constitute a real competition. Such papers may be included in competition with those presented in the following year.

Institute Prizes

The awarding of the Institute prizes shall be the responsibility of the Prize Awards Committee, which is appointed annually by the Institute President in accordance with the Bylaws. The Institute prizes will be presented at the regular Winter General Meeting.

The Institute or national prizes will consist of (a) one from each Division, (b) one for papers sponsored by general committees and articles in *Electrical Engineering*, and (c) a Best Student Paper.

(a) *Division Papers:*

Only Transactions papers shall be eligible for Division prize awards. There shall be one first prize for each Division consisting of a certificate and $100. In special cases, additional certificates may be awarded at the discretion of the Committee on Prize Awards. All Transactions papers will be considered for Division prizes without formal offering in competition. The awards will be presented at the regular Winter General Meeting.

The Division prizes shall be judged by the Prize Awards Committee upon recommendation of a Prize Awards Subcommittee of each of the Divisions.

As an aid to the Prize Awards Committee, a Prize Awards Subcommittee shall be appointed by each Division chairman at the beginning of the administrative year and shall consist of not less than three members of the Division. Recommendations for Division prizes for papers presented during the administrative year shall be submitted by this Subcommittee to the Prize Awards Committee not later than September 1 of the following administrative year.

To assist the Divisional Prize Awards Subcommittee each Technical Committee Chairman is urged to submit nominations for the National Prizes to his Divisional Prize Awards Subcommittee, accompanied by a brief statement giving reasons why each paper is worthy of consideration.

(b) *Papers Sponsored by General Committees and Articles in Electrical Engineering:*

To encourage the authors of papers sponsored by general committees, and authors of articles in *Electrical Engineering*, an additional prize consisting of a certificate and $100 has been set up. All such papers will be considered for this award if submitted in triplicate to the Institute Secretary before July 31 of the administrative year and accompanied by a written statement as to why it is of prize caliber.

(c) *Best Student Paper:*

A Best Student Paper award also is included among the Institute awards. This consists of a certificate and $100. All student papers which have won a prize in Branch or District student competition will be considered for an Institute award if submitted in triplicate to the Institute Secretary before July 1 of the administrative year in which presented and accompanied by a written statement as to when and where presented.

District Prizes

The awarding of District prizes shall be the responsibility of the Award of District Prizes Committee which shall be appointed annually by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be the same as judges of written presentation, and they may include Associate or non-Institute members when necessary. The District prizes will be presented at a meeting within the District or at some other meeting upon approval of the District Executive Committee.

The District Prizes comprise (a) a best paper prize for any Transactions paper prepared by a resident of the District consisting of a certificate and $75, and a second prize consisting of a certificate and $50; and (b) a best paper prize presented to an undergraduate Student member in district competition consisting of a certificate and $25, and a second Student prize consisting of a certificate only.

(a) *Best District Transactions Paper:*

All Transactions papers presented during the administrative year, nominally August 1 to July 31, will be considered for District prizes without formal offering in competition. Transactions papers selected by Technical Committees of the Divisions and the General Committees for consideration as Institute prize papers will be classified according to District allocation, as determined by the residency of the author or authors. In the case of member coauthors from more than one District, a Transactions paper shall be eligible in all such Districts. A list of these Transactions papers for each District shall be forwarded by the Headquarters staff to the District Secretary for consideration as the District prize papers. In addition to these papers, each District may include for consideration as District prize papers, any eligible Transactions paper, whether or not it is among those called to their attention by Headquarters. A paper is eligible to receive both Institute and District prize awards.

(b) *Best Student Paper:*

The District Student Prize Papers competition is limited to papers which have received first prize in a Branch competition.*

Section Prizes

The awarding of Section prizes shall be the responsibility of the Section Prizes Committee which is appointed annually by the Section chairman and shall consist of not less than three Associate Members, Members, or Fellows of the Institute.

Prizes also are available for papers presented by Section members, but because of the wide variation in the character of the Sections, no very definite rules are provided. A sum of $100 is available for each Section to be divided at the discretion of the Section, but with a maximum

* Additional Prizes provided by the Members-for-Life Fund include a trip to the Summer General Meeting for the first prize, $25.00 for second prize, and $15.00 for third prize.

of $50 for any one prize and a certificate for each winner. When three or more papers are submitted for competition to the Secretary of the Section, arrangements shall be made for presentation before the Section at a meeting set aside for that purpose and a committee selected to judge the contest.

The award of the Section prize will be made at a meeting of the Section.

Branch (Undergraduate) Prizes

The Award of Branch Prizes Committee shall be appointed annually by the Student Counselor and shall consist of not less than three Associate Members, Members, or Fellows. When necessary, a non-Institute member may be selected.

Two awards for each Branch are available. The first prize consists of a certificate and $10 plus an allowance of 13¢ per mile one way for 800 miles or less and 10¢ per mile one way for the remaining distance to the District student prize paper competition. The second prize consists of a certificate. When three or more papers are submitted to the secretary of the Branch, arrangments shall be made for presentation before the Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

It is not the primary purpose of Student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end, emphasis has been placed on written presentation and the exercise of engineering thinking rather than on technical value. The papers shall be graded in accordance with the following basis:

A. Written Presentation
   Originality—13%
   Survey of subject (analytical procedure)—10%
   Importance—10%
   Appropriateness—6%
   Mode of expression
   (1) Logical organization of material for clarity, forcefulness, and interest. Appropriate headings are essential (7%)
   (2) Concise and coherent expression of thoughts in good English and with proper choice of words (7%)
   (3) Effective and judicious use of pictorial and graphical presentation (7%)
   Adequate introduction and closure (6%)

B. Oral Presentation
   Speaking technique—12%
   Style (organization of material)—12%
   Introduction and conclusion—5%
   Discussion—5%

For purposes of grading student papers, originality should be interpreted to include credit for (a) individual treatment of the subject by the author and his own mode of expression in writing the paper, and (b) exposition of a technique, apparatus, device, investigation, theory, or analysis that is original with the author. No credit under originality should be allowed for direct copying of other work.

The award of the Student prizes should be made at a meeting of the Branch.

Institute and District prizes for Student papers are also provided as indicated under Institute Prizes (Section *c*), and District Prizes (Section *b*).

Effective Date of Rules

These rules became effective with the administrative year beginning on August 1, 1956.

Procedure for Revision

These rules for prize awards are subject to revision by the Board of Directors of the Institute.

Building Fund Discussed at AIEE Section Delegates Meeting

"WHY don't engineers do something for themselves?"

The answer to that question, posed by ex-President Herbert Hoover in a letter concerning the raising of funds for a new engineering headquarters many years ago, was answered by AIEE President W. J. Barrett at the Section Delegates meeting of the Summer General Meeting in Buffalo, N.Y., June 24, 1958. Chairman H. H. Sheppard of the Sections Committee presided at this meeting with W. E. Scholz serving as secretary.

Mr. Sheppard announced that the Jackson Subsection of the Memphis, Tenn., Section had been organized on February 5, 1958; also, that the Palm Beach Subsection of the Miami, Fla., Section and the Upper Monongahela Valley Subsection of the Pittsburgh, Pa., Section would become effective August 1, 1958. He also announced that the transfer of four California counties from the San Francisco to the Sacramento Section would become effective August 1, 1958, and that eight towns in Middlesex County, Mass., would be transferred from the Boston to the Lynn Section on the same date. Proposed transfers of 24 Iowa counties to the Iowa-Illinois Section and 40 South Dakota counties from the present Minnesota to the Iowa Section were to be considered by the Administration Department at its next meeting.

C. T. Pearce, Administration Department, told how a committee had been working to even up the load on the AIEE vice-presidents by redistributing some of the Sections. It was proposed to transfer the Erie Section from District No. 2 to District No. 1; the revised Iowa Section from District No. 5 to District No. 6; and three Michigan Sections from District No. 5 to District No. 11.

Mr. Pearce then told about the revised make up of the District Executive Committees, the voting powers, travel allowances, and titles of the personnel.

Chairman Sheppard introduced AIEE President W. J. Barrett, who, after welcoming the Section Delegates, gave an historical summation of the need for another headquarters and the selection and acquisition of the site for the new United Engineering Center.

In the course of his talk, Mr. Barrett told how ex-President Hoover's remark, "Why don't engineers do something for themselves?" was the needed spark to set matters going for the new building. There were bids from other cities for the headquarters, but a survey made in 1955 showed that the building should be in midtown New York City. It was found that modernizing the present 39th St. headquarters would cost about as much as a new building, so it was decided by the five Founder Societies to acquire a new site and build on it.

Realtors were commissioned to acquire the property and after prolonged negotiations, 0.9 acre on the United Nations Plaza between 47th and 48th Streets was in the Societies' hands. The value of the present building and the reserve funds in the Societies' treasuries were sufficient to buy the land. The new building will cost $8 million.

Mr. Barrett then told the delegates the parts they would play in the raising of the money for the Institute's quota of $900,000 for the new building, the design of which will be such that space can be added in the future if necessary. Different quotas have been assigned to the Sections: for example, that for the New York Section is $300,000.

In addition to the five Founder Societies, 10 other engineering societies will have their headquarters in the United Engineering Center. The net useable floor space will be 2½ to 3 times that of the present building and, thus, will provide for the expansion of the societies as they grow throughout the years.

F. H. Knapp, chairman, Registration of Engineers Committee, explained the Institute's policy of encouraging AIEE members to register as professional engineers. This committee wrote to the Section chairman urging that a standing registration committee be established to work with state boards on getting members to register. He referred to "Your Next Step—Registration" by A. E. Paige, which was published in the June, 1958 issue of *Electrical Engineering*, p. 491, as being an aid to section committee personnel in the procedure of getting men to register. He suggested working with Student Branches along these lines.

J. R. Kerner, chairman, Subcommittee for Section Growth Awards, announced the results of the Section growth competition for 1957-58. The leading five Sections

in each of the two classifications were as follows:

Larger than Average:

1. St. Louis Section	— 36.2%	(Gavel)
2. Portland Section	— 20.2%	(Certificate)
3. North Texas Section	— 18.9%	
4. San Francisco Section	— 18.5%	
5. Los Angeles Section	— 7.2%	

Smaller than Average:

1. Tampa Section	— 102.2%	(Gavel)
2. Rochester Section	— 45.2%	(Certificate)
3. South Bend Section	— 38.9%	
4. Montana Section	— 38.6%	
5. Utah Section	— 37.5%	

J. J. Callahan, chairman, Admission and Advancement Department, told the delegates about the scope of the department. He said that the Membership Committees are the main working groups in the Sections and that the continuing growth of the Institute depended on their efforts. He asked that the forms for application of AIEE membership and advancement be filled in completely as the Board of Examiners has a large work load and incomplete forms hinder their functioning. The Board of Directors has approved another year of rebate, which will be handled twice a year. He also asked that the new locations of graduated students be promptly reported so that they can be brought into their new Sections' activities.

J. A. Parrott, chairman of the Public Relations Committee, told about the scope of his committee and then introduced R. C. Mayer, Jr., of the Institute's public relations consultants. Mr. Mayer showed the 18 booklets prepared for the Sections in their various activities and told how they could be used.

Mr. Parrott then told about the objectives of the Institute's public relations work: conveying information of the Institute's functions; attracting capable people to the electrical engineering profession and to AIEE; and keeping members aware of AIEE and supplying their needs. He then invited questions from the floor and several delegates told about the establishment of technical groups in their respective Sections. It was brought out that the majority of Sections sponsor dinner meetings.

E. D. Barcus, the Los Angeles Section delegate, described the make-up of that Section's executive committee. It was found necessary to increase this from 8 to 23 members and the reorganization is still incomplete. They are planning to increase service to their membership of 4,500 and to break down their divisions so that the diversification will be of greater interest to their members.

Mr. Hickernell, AIEE treasurer and president-elect, presented his report, which was the same as the one he presented at the annual meeting.

J. R. Kerner, chairman of the Subcommittee on Section Finances, supplemented his report presented at the Winter General Meeting with the recommendation that the results of a full year of operation under the temporary plan be considered before a final recommendation be made. On April 30, 1958, the Board of Directors voted to adopt this temporary plan of rebate of entrance and transfer fees for the entire 1958-59 season. The regular allotment check for each Section in October 1958 will include compensation for increased number of meetings based upon the total number of eligible meetings reported for the 1957-58 year plus a rebate of the entrance and transfer fees collected between April 1 and September 30, 1958. Fees collected from October 1, 1958, to March 31, 1959, will be rebated to the Sections during April of next year.

Mr. Kerner stressed that Sections should impress the fact on their members to pay their dues before October 1 so that Sections will get the $1.20 per man.

Mr. Grimm, chairman of the Student Branches Committee, explained how the Sections are being notified with what firms recently graduated student members are connected. He asked that Sections set up Reception Committees and look up the graduates as soon as they move into the vicinity.

J. J. Anderson showed the AIEE diploma which may be obtained by Fellows, Members, and Associate Members. (See p. 837). A certificate may be obtained by Affiliate Members. He stressed the publicity value of a membership diploma. He also stated that certificates can be had by Past Chairmen.

Mr. Sheppard then announced that the 1958-59 edition of the AIEE Yearbook would be published next Fall.

G. B. Schliecher, chairman of the Philadelphia Section, described the educational activities of his Section. In 1938, several "discussion groups" were formed and in 1955 these were reorganized into "technical divisions."

In 1947, a symposium on "Engineering Mathematics" by the Section was highly successful with an attendance of 75 members. Since then, several lecture series each year have been held at a cost ranging from $3 to $6 for a six-lecture course. During the 1957-58 season, three lecture courses were conducted: "Electrical Design of an Industrial Plant"; "Modern Communications," and "Components for Computers." The registration for the first two was 136, and 176 attended the last. The fees charged resulted in a profit for the Section. It is planned to have three lecture series next Fall and three more next Spring.

Mr. Schliecher explained the refund certificates for those nonmembers who join one of the participating societies within a limited time. If a nonmember pays a $20 fee for an 8-session course, he would receive a refund certificate for $8, the difference between his fee and $12 for members. If his application for membership is accepted and he receives his bill from headquarters, he encloses his certificate in lieu of its face value and pays the difference in cash. Headquarters presents the certificate for redemption to the Section.

Mr. Sheppard announced that the delegate from the AIEE Hawaii Section invited members who planned to attend the Pacific General Meeting in August, to visit his Section.

Dixon Lewis, chairman of the Ad Hoc Committee for the AIEE 75th Anniversary, showed the design which will be used on Institute letterheads during 1959 (see illustration). The slogan adopted is "75 Years—A Prologue to the Future." He told about some of the events planned for the coming year.

DESIGN which will be used on Institute letterheads during 1959. The slogan adopted for the AIEE 75th Anniversary is "75 Years—A Prologue to the Future."

Mr. Sheppard thanked the members for submitting promptly the names for new technical committee personnel. He also answered questions from the floor concerning the member gifts campaign for the new United Engineering Center.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until September 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before September 26.

58-869 The Calculation of Incremental Transmission Losses and the General Transmission Loss Equation. *R. E. Watson, W. O. Stadlin*

58-880 Liquid Dielectrics in an Electric Field. *W. H. Middendorf, G. H. Brown*

58-882 Corona and Withstand Tests in Oil. *F. J. Vogel*

Reprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

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Announcement to AIEE Members

DIPLOMAS

now available for Associate Members

CERTIFICATES

now available for Affiliate Members

Both the diplomas and certificates are available in attractive laminated plastic plaques ready for hanging in your home or office at only $3.50 (see illustration).

Fellow and Member diplomas are also available in this form at the same price of $3.50. For those who already have their diplomas and wish to have them emplaqued, a charge of only $2.50 will be made if original diploma is returned with order and provided diploma is no larger than 14 by 10½ inches.

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To American Institute of Electrical Engineers
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This is an order for one emplaqued diploma or certificate in the grade of

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(Contents—Printed Matter) Printed in U.S.A.

United Engineering Center—
A Symbol of Engineering Achievement

DURING THE PAST YEAR, you, as AIEE members, have been told about the acquisition of a site and plans for the Institute's new headquarters—the United Engineering Center. In December 1957, the architects' sketch of the new building was shown on the cover of *Electrical Engineering* and a photograph of the model of the building is shown herewith.

So you have an idea of where your Institute's future headquarters will be—on three floors of an 18-story modern structure, on a site described as one of the most desirable in New York City, on the United Nations Plaza between 47th and 48th Streets.

The United Engineering Center will be a symbol of engineering achievement, something in which you as an AIEE member can take great pride, something you have helped build.

As with any great engineering project, it takes time to get organized so that the project's functioning will be smoothly successful. The first phase of this organizing has been accomplished: under the direction of Dr. L. M. Goldsmith, a plan has been evolved whereby every AIEE member will be able to do his part and have a share in this great engineering venture.

Because AIEE has the largest membership of any of the 15 engineering societies whose headquarters will be in the United Engineering Center, it has the largest quota for member gifts: $900,000.

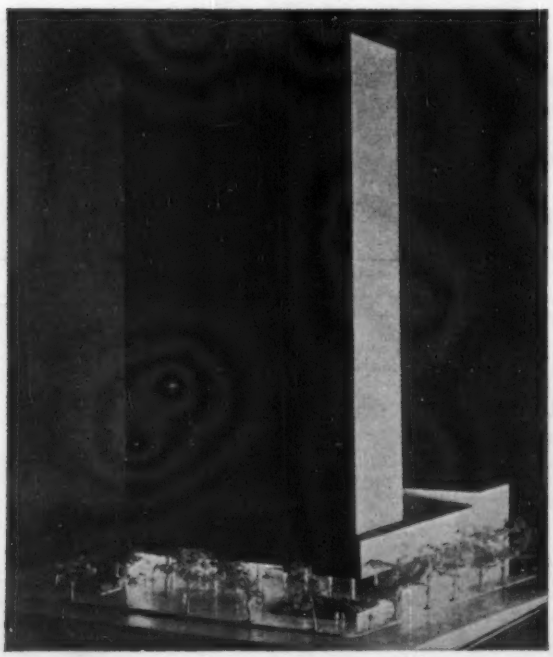
AIEE will use its District-Section organization to reach every member personally with a face-to-face appeal for a pledge. Institute Vice-Presidents have organized their Districts and the Section Chairmen have organized their Sections to carry through this objective.

At the Summer General Meeting in Buffalo, N.Y., Dr. Goldsmith expressed great satisfaction over the Vice-Presidents' reports of the progress that had been made in the Institute's 13 Districts. At that time, one District had already raised 5% of its quota!

There will be no mailed solicitation. Whoever calls on you can answer any questions you may have. You will be kept informed of this campaign's progress—one in which you will be proud to share.

San Francisco Section Donates $1,000 to United Engineering Center Building Fund

During the Conference of vice-presidents and District secretaries held at the AIEE Summer General Meeting in Buffalo, N.Y., June 22-27, 1958, Vice-President O. A. Gustafson of the Pacific District presented L. M. Goldsmith, chairman of the AIEE Member Gifts Campaign, with a check for $1,000 as a donation from the treasury of the San Francisco Section toward the United Engineering Center Building Fund. The gift was gratefully acknowledged by Chairman Goldsmith and the thoughtfulness of the San Francisco Section sets an example whereby other Sections may see their way clear to advance the welfare and services of the profession.



MODEL of the $10 million United Engineering Center which will be erected on United Nations Plaza between 47th and 48th Streets in New York City. Chairman of the AIEE Member Gifts Campaign for the new building, now in progress, is Dr. L. M. Goldsmith.

AIEE and NEMA Sponsor Cleveland Conference

Practical problems dealing with every type of proved insulation system will be discussed at the First National Conference on the Application of Electrical Insulation, to be held at Cleveland, Ohio, September 3-5, 1958. This is the first conference of this type to be held in the United States. The program for this conference was arranged during a meeting of the Conference Committee members at the National Electrical Manufacturers Association (NEMA) headquarters in New York, N.Y., under the direction of J. R. Perkins, of The Du Pont Company, general chairman of the Conference, and H. H. Chapman, Jr., of Owens-Corning-Fiberglas, program chairman.

Co-sponsors of the Conference are the AIEE and NEMA.

The Mayor of Cleveland, A. J. Celebrezze, will welcome those attending the Conference at Wednesday's luncheon. Other luncheon speakers include W. V. O'Brien, vice-president and general manager, Apparatus Division, General Electric Company, and president of NEMA; and L. F. Hickernell, vice-president in charge of engineering, Anaconda Wire & Cable Company, and president of AIEE.

Two separate dinner meetings will be held on September 3. One, sponsored by the AIEE Electrical Insulation Committee, will hear Dr. L. J. Berberich, of Westinghouse Electric Corporation, who was instrumental in the establishment of the committee and was also a leader in the movement to hold the Cleveland Conference. K. N. Mathes, of General Electric, will be in charge of the dinner. The second dinner is in charge of A. S. Gray, executive vice-president of Insulation Manufacturers Corporation, a pioneer in the field of distribution of electrical insulating materials.

The organizing committee decided to hold concurrent sessions at Cleveland, with topics divided according to equipment category, as follows: rotating equipment, transformers, controls and instrumentation, and electronics.

Under the direction of R. V. Lohse, of the Johns-Manville Corporation, a preprint booklet is being prepared for distribution to all those attending the Conference. Many kinds of insulation, such as magnet and hook-up wire, varnishes, flexible insulation, mica combinations, laminates, and liquid dielectrics will be discussed.

Each day the morning sessions will consist of papers delivered by representatives of electrical insulating materials manufacturers. In the afternoon, sessions presentations will be made by electrical equipment manufacturers. Ample time is also reserved for open forum discussions.

An additional feature of the Conference will be commercial and technical exhibits by the insulation and equipment manufacturers. Most of these will illustrate topics dealt with in the Conference sessions. Exhibit hours are arranged so as to conflict as little as possible with the technical sessions.

Registration is open to all desiring to attend. The fee is $15. Charge for the Wednesday luncheon is $4 and for the Wednesday dinners $5.

Papers Presented at the 1958 AIEE Summer General Meeting

A LISTING of the papers presented at the 1958 Summer General Meeting of the Institute, June 22-27, Buffalo, N. Y., follows. Copies of numbered papers are available to members for 40¢ each and to nonmember for 80¢ each. Send order and remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y. Papers marked CP* have not been printed by the Institute.

Monday, June 23

9:00 a.m. Morning Sessions

Radio Communications and Radar Interference

CP.* Design Characteristics of Some Existing Canadian Communication Systems Using Scatter Propagation. *H. J. von Baeyer*, Royal Canadian Air Force; *F. M. Banks*, Bell Telephone Co. of Canada.

58-816. Tropospheric Scatter System Design. *L. P. Yeh*, Westinghouse Electric Corp.

58-383. Factors Affecting the Use of Over-the-Horizon Links in Telecommunication Networks. *C. A. Parry*, Page Communications Engineers, Inc. (Re-presented for discussion.)

58-817. Radar Interference to Microwave Communication Services. *R. D. Campbell*, American Telephone and Telegraph Co.

Power Generation

58-794. The Electrical Features of the Sir Adam Beck Niagara Pumping-Generating Station. *W. D. Small*, The Hydro-Electric Power Commission of Ontario.

57-939. Friction and Windage Loss Tests of McNary Generators with Coupled and Uncoupled Turbine. *D. R. Cox, R. L. Krahn*, U. S. Army Corps of Engineers.

CP58-876. Electrical Features of the Upper Raquette River Power Project. *W. C. Van Dyke*, Niagara Mohawk Power Corp.

CP58-877. The Kelsey Hydroelectric Development on the Nelson River, Manitoba. *L. M. Hovey*, The Manitoba Hydro-Electric Board.

Substations

CP58-872. Trends in the Welding of Aluminum Bus Connections. *M. Brenner*, Penn-Union Electric Corp.

58-873. Silver Plated Aluminum Bus Conductors. *C. E. Burley*, Reynolds Metals Co.

CP58-874. Method of Comparing High-Voltage Substation Diagrams. *K. R. Knights, L. M. Gordon*, The Hydro-Electric Power Commission of Ontario.

58-875. Criteria for Substation Design on the British Columbia Electric System. *F. O. Wollaston, M. B. Callander, R. E. Clay*, B.C. Engineering Co., Ltd.

Semiconductor Rectifiers

58-926. Thermal Impedance of Cooling Fins. *E. J. Diebold, W. Luft*, International Rectifier Corp.

58-927. Forward Current Surge Failure in Semiconductor Rectifiers. *F. E. Gentry*, General Electric Co.

58-928. The Current Limiting Fuse as Fault Protection for Semiconductor Rectifiers. *F. W. Gutzwiller*, General Electric Co.

CP.* A Report on Specific Transient Voltage Problems Encountered in the Development of Power Supplies Using Silicon Rectifiers. *P. E. Kolk*, Bell Telephone Laboratories.

Transmission and Distribution

58-824. Distribution System Primary-Feeder Voltage Control—I A New Approach Using the Digital Computer. *H. E. Lokay, D. N. Reps*, Westinghouse Electric Corp.

58-891. Distribution System Primary-Feeder Voltage Control—II Digital Computer Program. *D. N. Reps, G. J. Kirk, Jr.*, Westinghouse Electric Corp.

58-827. Distribution System Primary-Feeder Voltage Control—III Computer Program Application. *H. K. Amchin, R. J. Bentzel*, American Gas & Electric Service Corp.; *D. N. Reps*, Westinghouse Electric Corp.

CP58-893. The Protection of the Customers' Service through Isolated Transformers. *P. W. Shill*, H. G. Acres & Co., Ltd.

Tuesday, June 24

9:00 a. m. Morning Sessions

Mobile Radio Systems

CP58-813. City-Wide Personal Signaling at Allentown-Bethlehem, Pa. *C. R. Kraus*, The Bell Telephone Co. of Pa.

CP58-814. Pagemaster Receiver and Modulation Equipment. *J. W. Young*, Stromberg-Carlson Co.

CP58-989. Systems Engineering of Personal Radio Signaling Systems. *W. Strack*, Bell Telephone Labs., Inc.

58-815. An Integrated Mobile-Microwave Communications System for the Massachusetts Turnpike. *R. F. Lowe*, General Electric Co.

CP.* VHF Transistorized Pocket Receivers for Personal Communication and Paging Services. *G. A. Robertson*, Radio Corp. of America.

Electric Braking

CP58-993. Electric Brakes for Transit Vehicles. *B. A. Widell, H. H. Hennel*, General Electric Co.

CP58-979. Regenerative Braking. *A. W. Manser*, London Transport Executive.

CP58-810. The Complementary Role of Air and Dynamic Brakes in Rail Transportation. *C. M. Hines*, Westinghouse Air Brake Co.

Industrial Control

CP58-807. Static Exciters and Voltage Regulators for Portable Alternators. *D. W. Drews*, Westinghouse Electric Corp.

CP58-947. A Universal Logic Symbology. *E. Boote*, Canadian General Electric Co., Ltd.

CP58-953. A Transistorized Static Switching Logic Element. *N. L. Carlson*, Canadian General Electric Co., Ltd.

CP58-808. A Comparison of Adjustable Frequency A-C and Synchrotie Systems for Synchronized Drives. *A. T. Bachelor*, Westinghouse Electric Corp.

58-809. Temperature of Conducting Ribbon Magnet Coils. *J. F. H. Douglas*, Marquette University.

Load-Frequency Control

CP58-855. A Unique System for Economic Power Dispatch. *J. W. Hoag, G. W. McKnight*, Minneapolis-Honeywell Regulator Co.

CP58-931. Factors To Be Considered in Selecting a Load-Frequency Control System. *W. C. Van Dyke*, Niagara Mohawk Power Corp.

CP58-930. Operation Experience with Command Type Load-Frequency Control Equipment. *W. D. Wilder*, Niagara Mohawk Power Corp.

58-932. A Speed-Setting Transducer. *N. G. Alvis*, Woodward Governor Co.

58-847. System Control Aided by Governor Transducer. *R. D. Nevison*, The Hydro-Electric Power Commission of Ontario.

Magnetic Amplifiers

58-898. Transistor-Oscillator Induction—Motor Drive. *W. H. Card*, University of Toronto.

CP58-899. Progress Report of the Standards Subcommittee of the AIEE Magnetic Amplifier Committee. Presented by F. G. Timmel.

57-776. Reactions of Bistable B-H Loops on Magnetic Amplifiers. *R. E. Morgan*, General Electric Co. (Re-presented for Discussion.)

58-773. A-C Controlled Magnetic Amplifiers. *E. W. Lehtonen, E. A. Cronauer*, Sperry Gyroscope Co. (Re-presented for Discussion.)

58-774. Elimination of Magnetic Amplifier Control Circuit Inductance. *D. P. Chandler, R. W. Downing*, North American Aviation, Inc. (Re-presented for Discussion.)

58-775. High Efficiency Push-Pull Magnetic Amplifier and Its Use as a D-C Shunt Motor Drive. *C. L. Boyajian*, General Electric Co. (Re-presented for Discussion.)

2:00 p.m. Afternoon Sessions

Rapid Transit

CP58-811. Semiconductor Battery Charging Control System. *E. W. Ames*, Westinghouse Electric Corp.

CP58-812. Progress in Control Design for Rapid Transit Subway Cars. *G. R. Purifoy*, Westinghouse Electric Corp.

CP58-967. Effect of High-Performance Rapid-Transit Cars upon Traction Substations—An Exploratory Appraisal. *E. J. Hogan, J. C. Price*, General Electric Co.

Conversion of Industrial Power Systems from 25 to 60 Cycles

CP.* Problems in Changing a Steel Plant Power System from 25 to 60 Cycles. *C. G. Dimitt*, U. S. Steel Corp.

CP58-973. The Effect of Frequency Conversion on Expansion and Modernization of the Power System in a Rubber Mill. *D. Lees*, Goodyear Tire & Rubber Co. of Canada; *D. V. Fawcett*, Canadian Westinghouse Co., Ltd.

CP58-949. New Thoughts on Industrial Power in the Niagara Frontier. *T. J. Brosnan*, Niagara Mohawk Power Corp.

CP58-986. Frequency Standardization of Industry in Ontario. *F. O. Price*, The Hydro-Electric Power Commission of Ontario.

Indicating and Recording Instruments

58-933. A System for Gauging Plating Thickness. *R. G. Myers*, Argonne National Lab.; *D. L. Waidelich*, University of Missouri.

58-367. Magnetic Field Strength in Oersteds near Large Rectangular Conductors. *J. H. Miller*, Weston Electrical Instrument Corp. (Re-presented for Discussion.)

58-934. On the Application of Zener Diodes to Expanded Scale Instruments *A. J. Corson*, General Electric Co.

CP58-935. A New Round Chart Weatherproof Recording Instrument with Sealed Inking System. *D. F. Roerty, S. G. Hayter*, Westinghouse Electric Corp.

58-850. A Triple Action Positioning Controller Using a Magnetic Modulator. *C. V. Bullen*, Barber-Colman Co.

System Operation

58-853. 28 Years' Operating Experience of America's First Pumped Storage Hydro

Plant. *C. T. Hughes, C. M. MacWilliam,* The Connecticut Light & Power Co.

58-866. 27 Years of Operating a Hydro Station in Connection with a Water Supply System. *A. Ferreira,* Western Massachusetts Electric Co.

58-867. A Method of Scheduling Optimum Operation of Ontario Hydro's Sir Adam Beck–Niagara Generating Station. *B. Bernholtz, W. Shelson, O. Kesner,* The Hydro-Electric Power Commission of Ontario.

58-868. Benefits of Line Capacitors Extended by Remote Automatic Control. *E. M. Gordy, W. L. Ridenhour, C. Wasserman,* Baltimore Gas And Electric Co.

Rotating Machinery

58-896. D-C Dynamic Braking of Double-Cage Induction Motors. *O. I. Butler,* University of Sheffield; *M. N. Abdel-Hamid,* University of Cairo.

55-761. Induction Motor Temperature Characteristics. *J. F. Heidbreder,* Westinghouse Electric Corp. (Re-presented for Discussion.)

58-778. Calculation of Induction Motor Torque and Power. *W. H. Middendorf,* University of Cincinnati.

58-278. Water Cooling of Turbine-Generator Stator Windings. *G. V. Browning, C. H. Holley, J. F. Quinlan,* General Electric Co.

Magnetic Amplifiers

58-856. Characteristics of Magnetic Amplifiers Utilizing Square Loop Core Material and Square Wave Supply Voltage. *H. H. Britten,* General Electric Co.

58-858. A New Control Amplifier Using a Saturable Current Transformer and a Switching Transistor. *R. E. Morgan,* General Electric Co.

58-897. A Power Method of Measuring the Torque-Producing Output of a Magnetic Amplifier Driving One Phase of a 2-Phase Servo Motor. *S. J. Reisman,* Westinghouse Electric Corp.; *E. H. Bowman,* Sandia Corp. (Re-presented for Discussion.)

58-776. Triggering in the Reversible Half-Wave Magnetic Amplifier. *D. L. McMurtrie, J. P. Ward,* Raytheon Mfg. Co. (Re-presented for Discussion.)

58-792. A Comprehensive Study of Magnetic Amplifier Design—Part I, A Practical Design Method. *R. M. Hubbard, M. M. Bishop,* Boeing Airplane Co. (Re-presented for Discussion.)

58-793. A Comprehensive Study of Magnetic Amplifier Design— Part II, Toroidal-Core Dimensional-Ratios as a factor in Magnetic Amplifier Design. *R. M. Hubbard, M. M. Bishop,* Boeing Airplane Co. (Re-presented for Discussion.)

Computing Devices

58-929. Magnetic Drum Components for High Storage Density. *K. Hong,* Massachusetts Institute of Technology.

CP.* A Medium Speed Data Acquisition System. *R. G. Lex, M. Garden, J. J. Hitt, W. G. Kieslich, W. P. West,* Leeds & Northrup Co.

CP.* Data Acquisition Systems Employed in Rocket Motor Tests at Bell Aircraft Corp. *R. C. Deegan, H. M. Conroy,* Bell Aircraft Corp.

Space Vehicles, Satellites, and Missiles

CP.* The Celestial Mechanics of Space Flight—Physical Attributes and Variables of Control. *I. M. Levitt,* The Franklin Institute.

CP58-955. Control and Instrumentation Problems Associated with the Guidance of Space Flight Vehicles. *C. S. Draper,* Massachusetts Institute of Technology.

CP.* Problems of Dynamic Stabilization in Large Rocket Vehicles. *R. Hanna,* Douglas Aircraft Co.

CP58-957. Instrumentation Requirements for Altitude Control of Satellites and Space Vehicles. *J Farrior,* Army Ballistic Missile Agency.

CP.* Inertial Control of Satellite Attitude. *R. E. Roberson,* North American Aviation, Inc.

CP58-961. Instrumentation of Attitude Control of Satellites, and Interplanetary Vehicles. *W. E. Frye,* Lockheed Missile Systems Division.

CP58-948. Component and System Design for Minimum Weight and Volume, Maximum Accuracy, and Reliability. *J. L. Bowers,* Convair-Astronautics.

Wednesday, June 25

9:00 a.m. Morning Sessions

Televison and Aural Broadcasting

CP.* Analysis of Compatible Single Sideband Systems. *G. A. Olive,* RCA Laboratories.

CP58-951. Design Methods To Improve the Stability of AM Directional Antenna Systems. *G. H. Brown,* Radio Corp. of America.

CP58-983. Salient Problems in Television Receiver Transistorization. *F. Mural,* Philco Corp.

CP.* A Study of UHF Television Ghostings in a Shadowed Valley and What To Do about It. *D. K. Peterson,* RCA Laboratories; *R. K. Blackburn,* WHEC-TV.

Aircraft—Ground Support and Lighting

CP58-963. Ground Electrical Power Support. *C. B. Graff, Major H. H. Barton,* Headquarters, Air Research and Development Command.

CP58-840. Development and Application of an Electrical Power System Analyzer. *E. L. Clark, A. J. DiStio,* Beech Aircraft Corp.

57-458. Lighting the Modern Commercial Aircraft. *P. E. Massie,* Day-Ray Products, Inc. (Re-presented for Discussion.)

58-839. Development of a Dimmable Aircraft Fluorescent Light System. *E. W. Banios,* Ramo-Wooldridge Corp.

Industrial Plant Power Systems

CP58-977. Factors in the Design of a Steel Plant Power System. *A. J. F. MacQueen,* Patterson-Emerson-Comstock, Inc.

CP58-972. Problems Associated with the Conversion of Electric Smelting Furnaces from 25 to 60 Cycle Operation. *T. A. Leeds,* Electro-Metallurgical Co.

CP58-968. Power Systems for Electrolytic Plants. *F. L. Kaestle,* General Electric Co.

Symposium on Maintaining the Accuracy of Watt-Hour Meters in Service

CP58-805. Maintaining the Accuracy of Watt-Hour Meters in Service. *G.B.M. Robertson,* Philadelphia Electric Co.

58-425. Evaluation of Single-Phase Metering Practices Based on Meter Performance and Load Characteristics. *J. M. Vanderleck,* The Hydro-Electric Power Commission of Ontario (Re-presented for Discussion.)

CP58-982. A Discussion of Sampling Methods as Related to Testing of Watt-Hour Meters. *J. A. Morris,* American Gas & Electric Service Corp.

CP58-806. The Application of Statistical Sampling Methods of the Testing of Watt-Hour Meters. *C. V. Morey,* Consolidated Edison Co. of New York, Inc.

CP.* An Approach to a Sampling Plan for Testing Single-Phase Watt-Hour Meters. *R. D. Bader,* Baltimore Gas and Electric Co.

System Economics

58-865. Economic Operation of Variable-Head Hydro Plants. *A. F. Glimn, L. K. Kirchmayer,* General Electric Co.

CP58-952. Economic Complementary Operation of Hydro Storage and Steam Power in the TVA System. *R. N. Brudenell, J. H. Gilbreath, TVA.*

CP58-869. The Calculation of Incremental Transmission Losses and the "General Transmission Loss Equation." *R. E. Watson, W. O. Stadlin,* Leeds & Northrup Co.

CP58-870. Power System Planning Economics. *A. J. Wood,* General Electric Co.

Rotating Machinery

58-900. Ground Fault Protection of Unit Connected Generators. *M. N. Rajk,* Sanderson & Porter Engineers.

58-901. Synchronous Performance of Reluctance Motors by Improved Circle Diagrams. *J. F. H. Douglas,* Marquette University.

58-940. The Steinmetz Conception of the Single-Phase Squirrel Cage Motor. *E. Bretch,* Century Electric Co.

58-939. The Dilemma of Single-Phase Induction Motor Theory. *P. L. Alger,* General Electric Co.

CP58-849. Sources of Electromagnetic Vibration in Single-Phase Induction Motors. *L. W. Magyar,* General Mortors Corp.

Applied Mathematics

58-777. The Numerical Evaluation of Expressions Involving Complete Elliptic Integrals. *F. W. Grover,* Union College.

58-787. A Generalization of the Calculus of Finite Differences to Nonuniformly Spaced Variables. *G. Kron,* General Electric Co.

58-854. Reliable Stochastic Sequential Switching Circuits. *A. A. Mullin,* University of Illinois

CP58-995. Analysis of Transcendental Nonlinear Systems. *A. A. Wolf,* University of Pennsylvania.

Air Transportation—Machine Design

58-791. The Turbonator—Design and Development. *J. T. Duane, J. W. Harrison,* General Electric Co.

58-908. Computer Analysis of A-C Aircraft Generators. *J. R. M. Alger, J. T. Duane, E. F. Magnusson, R. T. Smith,* General Electric Co.

58-772. Effects of Operating Frequency on the Weight and other Characteristics of Missile Alternators and Transformers. *R. E. Turkington,* Radio Corp. of America.

58-832. Design of an Aircraft Power-Type Circuit Breaker 600 F Ambient. *B. O. Austin,* Westinghouse Electric Corp.

CP58-909. Simulated Altitude Carbon Brush Investigations. *W. H. Austry, J. E. Diehl, E. I. Shobert II,* Stackpole Carbon Co.

2:00 p.m. Afternoon Sessions

Television Broadcasting

CP.* Chroma-Key Color Inset System. *F. Gaskins, R. Kennedy,* National Broadcasting Co.

CP58-993. A New Image Orthicon Color Camera. *J. F. Wiggin,* General Electric Co.

CP.* Recording of Color Television on Magnetic Tape, *E. M. Leyton,* RCA Laboratories.

58-904. A Quadruplexer Allowing the Simultaneous Transmission of Two Complete Television Stations Using a Common Antenna. *G. B. MacKimmie,* RCA Victor Co., Ltd. (Re-presented for Discussion.)

Aircraft—Materials and Testing

CP58-843. Materials for Electrical Systems in High Temperature Aircraft. *D. K. McIlvaine,* Westinghouse Electric Corp.

CP58-835. High Temperature Electrical Insulation Materials for Missiles and Aircraft. *R. N. Evans,* WADC.

58-845. A Discussion of D-C High Potential Test Voltage for Aircraft Electrical Insulation. *L. B. Kilman, J. P. Dallas,* Hughes Tool Co.

58-841. Aircraft Switch and Relay Inductive Circuit Test Loads. *J. P. Dallas*, Hughes Tool Co.
CP58-912. Statistics Applied to Electrical Laboratory Evaluations. *F. Albrecht*, The Martin Co.

Electric Drives in the Metal Industry

CP.* Operation of Rectifiers in Parallel with Existing Generators To Increase Power for Hot Strip Mill Operation. *G. Eckenstaler*, Allis-Chalmers Mfg. Co.
CP.* Tandem Cold Reduction Mill Electric Drive Systems. *J. A. McCarthy*, Westinghouse Electric Corp.
CP58-946. Analysis of Arc Furnace Control Using Analog Computer. *K. G. Black, R. E. Bower*, General Electric Co.
CP58-903. An Automatic Gauge Controller for a 56-Inch Reversing Steel Mill. *R. L. Duke, L. R. Hulls*, Canadian Westinghouse Co., Ltd.

Transmission and Distribution

CP58-795. Jervis Inlet Overhead Crossing. *L. H. J. Cook*, B. C. Engineering Co., Ltd.; *R. A. McLachlan*, Dominion Bridge Co., Ltd.
58-886. Superposition of High-Voltage Transmission on Existing Medium Voltage Transmission Networks. *J. W. Graff*, Alabama Power Co.
58-885. New Method for Computing Bearing Capacity of Block Foundations in Transmission Lines. *O.D. Zetterholm, B. O. Pramborg*, Swedish State Power Board.
58-779. Horizontal Bundle Spacers. *R. J. Mather*, Bonneville Power Adm.; *A. R. Hard*, Washington State Institute of Technology.
CP58-937. Comprehensive Sag-Tension Data for Aluminum Conductors. *P. G. Malburg*, Aluminum Co. of Canada Ltd.; *W. Janischewskyj*, Aluminum Laboratories Limited.

Transformers

58-785. Progress in Routine Testing of High-Voltage Bushings. *D. L. Johnston*, General Electric Co.
CP58-882. Corona and Withstand Tests in Oil. *F. J. Vogel*, Allis-Chalmers Mfg. Co.
58-780. Characteristics of Thermosiphon Flow in a Model Transformer Oil Circuit. *J. J. Kunes*, Westinghouse Electric Corp.
CP58-936. Natural Frequencies in Transformer Windings. *I. Johansen*, Carnegie Institute of Technology.

Computers in Air Traffic Control

CP58-966. Programming Techniques in Real-Time Data Processing for CAA Air Traffic Control. *G. B. Harwell*, CAA Indianapolis.
CP58-958. Computers and Programming Techniques for Air Traffic Control. *R. A. Finkler*, General Precision Laboratory Inc.
CP.* Simulation Programming of Enroute Control Operations. *D. C. Lancto*, International Business Machines Corp.

Aircraft and Flight Test Instrumentation

CP.* A Digital Air-Ground Data Interchange System. *W. W. Fisher, D. E. Wassall*, Bendix Aviation Corp.
CP58-950. Use of Telemetering in Temperature Survey Work. *E. J. Brown*, McDonnell Aircraft Corp.
CP58-907. Development of Automatic Plotting Equipment for Telemeter Read-Out. *W. F. Sullivan*, McDonnell Aircraft Corp.

Air Transportation—General Interest

58-910. The Advantages of a Pneumatic Electrical Power System for High Mach Number Aircraft. *M. A. Slavin*, General Electric Co.
CP58-911. On the Art of Specification Writing. *P. W. Franklin*, Leland Electric Co.
CP58-846. A Transistorized Warning Light System for Aircraft. *W. Silbert*, The Martin Co.
58-836. Conductors and Conductor Protection. *R. Steiner*, Northrup Aircraft Inc.
CP58-964. Instrumentation for Precise Requirements of Power Supply Characteristics. *C. M. Groves*, Royal Radar Establishment of England.
CP58-938. Sequence Impedances of Airborne 3-Phase Power Distribution Cables. *D. S. Toffolo*, U. S. Naval Research Lab.

Thursday, June 26

9:00 a.m. Morning Sessions

Wire Communication Systems

58-386. Dial Switching of Toll Circuits in Independent Telephone Company Areas—Transmission Considerations from the DDD Standpoint. *J. N. Petrie*, Automatic Electric Co. (Represented for Discussion.)
58-905. Determination of the Least First Cost of a Cable-Carrier System. *R. Krzyczkowski*, Westinghouse Electric Co.
57-1070. Insertion Loss Filter Design Applied to Transistorized Carrier System. *T. Winkler*, Stromberg-Carlson Co. (Re-presented for Discussion.)
58-906. A Transistorized Compandor. *J. C. Perkins, Jr.*, Stromberg-Carlson Co., *D. A. Perreault, A. F. Perkins*, O'Hara Associates.
58-851. Standby Power for Pole-Mounted Equipment. *D. F. Jamieson*, Stromberg-Carlson Co.

Aircraft—Missiles, Satellites, Asteroids

CP58-913. Reliability Evaluation of Aircraft and Missile Equipment I. Theory of Small Sample Methods. *B. J. Wilson*, U.S. Naval Research Lab.
CP58-837. Unconventional Electric Power Supplies and the Weapon System. *Lt. R. G. Leiby*, WADC.
CP58-990. Application of Reserve Batteries in Missiles. *W. A. Tynan*. The Johns Hopkins University.
CP58-914. High Altitude Performance of Silicon Solar Cells. *K. L. Niebauer*, Boeing Airplane Co.
CP58-915. New Sources of Secondary Power for Satellites and Missiles. *H. Oman*, Boeing Airplane Co.

Transmission and Distribution

58-829. The Prestrike Theory and other Effects in the Lightning Stroke. *S. B. Griscom*, Westinghouse Electric Corp.
58-782. The Influence of the Prestrike on Transmission Line Lightning Performance. *S. B. Griscom, J. W. Skooglund, A. R. Hileman*, Westinghouse Electric Corp.
CP58-887. Anomalous Flashovers: What Are Their Fundamental Causes? *P. W. Shill*, H. G. Acres & Co., Ltd.
CP58-945. The Insulation Requirements of High-Voltage Transmission Lines for 115 Kv to 460/500 Kv. *P. L. Bellaschi*, Portland, Oreg.

Transformers

CP58-883. Phase-Angle Control Benefits Power System Interconnection. *H. W. Haberl*, Quebec Hydro-Electric Commission; *C. E. Moorhouse*, Canadian Westinghouse Co., Ltd.
58-786. Rapid Spot-Test Methods for the Evaluation of Used Transformer Oil. *R. E. Reinhard, W. E. Elliot, E. P. Schram*, Allis-Chalmers Mfg. Co. (Re-presented for Discussion.)

Philadelphia Section Installs Officers

AT THE MAY MAIN SECTION MEETING of the Philadelphia Section of AIEE, the following officers were installed for the 1958-59 year: (*left to right*) G. B. Schleicher, Philadelphia Electric Company, chairman; W. O. Mascaro, Atlantic Refining Company, treasurer; M. L. Stoughton, I-T-E Circuit Breaker Company, vice-chairman; and R. L. Halberstadt, Bell Telephone Company of Pennsylvania, secretary. Elected to the board of managers were: W. C. Bloomquist, General Electric Company; R. T. Ferris, Philadelphia Electric Company; F. C. Powell, Drexel Institute of Technology; T. H. Story, Radio Corporation of America; and B. B. Young, Franklin Institute.

58-859. Features of the Atmoseal Oil Preservation System. *D. R. Baldwin, E. J. Sherman, R. J. Ringlee*, General Electric Co.

CP58-944. Transformer Pressure Relief Devices. *J. R. Barr*, General Electric Co.

Electrical Insulation Evaluation

57-257. Elongation as a Factor in Evaluating the Thermal Stability of Enameled Wire. *D. C. Westervelt, E. J. Croop*, Westinghouse Electric Corp. (Re-presented for Discussion.)

CP58-401. The Evaluation of Enameled Magnet Wire. *H. L. Saums, W. W. Pendleton*, Anaconda Wire & Cable Co. (Represented for Discussion.)

CP58-878. Effects of Neutron and Gamma-Ray Irradiation on the Dielectric Constant and Loss Tangent of Some Plastic Materials. *R. A. Weeks, D. Binder*, Oak Ridge National Laboratories.

CP58-879. On the Anomaly in Residual Polarization of BaTiO Ceramics. *Y. Satio, S. Yamanaka*, Tokyo Institute of Technology.

Computers in Electrical Power Systems

58-890. Digital Calculation of Network Functions Used in Loss Formula Studies. *R. W. Ferguson, R. W. Long, L. J. Rindt*, Westinghouse Electric Corp.

58-826. Logic for Applying Topological Methods to Electrical Networks. *R. T. Byerly, R. W. Long, C. W. King*, Westinghouse Electric Corp.

58-892. Digital Computer Aids in Power Pool Operation Studies. *H. M. McIntyre, C. W. Blake, J. S. Clubb*, Bonneville Power Adm.

2:00 p.m. Afternoon Sessions

Aircraft—Unconventional Generators

58-916. A Brushless D-C Generator for Aircraft Use. *J. T. Duane*, General Electric Co.

58-768. Magnetic Circuit Properties of the Flux Switch Inductor Alternator. *S. E. Rauch*, American Machine & Foundry Co.

58-831. The Limitations of Induction Generators in Constant Frequency Aircraft Systems. *E. Erdelyi, E. E. Kolatorowicz, W. R. Miller*, General Electric Co.

CP58-917. Energy Conversion Properties of Induction Machines in Variable-Speed Constant-Frequency Generating Systems. *M. Riaz*, Massachusetts Institute of Technology.

Sampled Data Control Systems

58-770. Staggered Sampling To Improve Stability of Multiple Sampler Feedback Systems. *R. E. Andeen*, Northwestern University.

CP58-801. Analysis of Sampled-Data Feedback Control Systems with Finite Sampling Duration. *J. Tou*, Purdue University.

CP58-802. A Technique for the Time-Domain Synthesis of Sample Data Systems. *H. C. Torng*, Cornell University.

58-803. Analysis of Cyclic Rate Sampled Data Feedback Control Systems. *R. E. Hufnagel*, Cornell University.

CP.* Transistor Circuits for an Error-Sampled Control System. *C. H. Knapp, E. Shapiro, R. A. Thorpe*, International Business Machines Corp.

Transmission and Distribution

58-781. Investigation of Switching Surges Caused by 345-Kv Disconnecting Switch Operation. *H. L. Rorden*, American Gas & Electric Service Corp.; *J. M. Dils*, Indiana & Michigan Electric Co.; *S. B. Griscom, J. W. Skooglund, E. Beck*, Westinghouse Electric Corp.

58-784. Analytical Studies of Overvoltages Caused by Disconnecting Switch Operation. *S. B. Griscomb, J. W. Skooglund, A. R. Hileman*, Westinghouse Electric Corp.

CP58-888. A Resistor for Suppressing Overvoltages Caused by Disconnecting Switch Operation. *C. W. Upton, C. M. Lane*, Westinghouse Electric Corp.

CP58-889. Switching Transients by Transient Analyzer Techniques. *K. A. Tuttle*, Bonneville Power Adm.

Transformers

58-311. "Insuldur"—Another Milestone in Transformer Insulation Development. *J. G. Ford, M. G. Leonard, J. Swiss, G. C. Gainer*, Westinghouse Electric Corp. (Re-presented for Discussion.)

58-881. Aluminum and Its Future in Power Transformers. *W. W. Orr*, Canadian General Electric Co.

58-884. The T-Connected 3-Phase Transformer. *E. W. Manning*, General Electric Co.

Liquid and Gaseous Insulation

CP58-880. Liquid Dielectrics in an Electric Field. *W. H. Middendorf, G. H. Brown*, University of Cincinnati.

CP58-978. Further Experience with the AIEE Subcommittee Test Cell for Gaseous Dielectrics. *M. L. Manning*, McGraw Electric Co.

CP58-326. Properties of Octafluorocylobutane —A Dielectric Gas. *F. W. Blodgett*, E. I. du Pont de Nemours & Co. (Inc.)

57-242. The Effect of Space-Charges on the Electric Breakdown of Sulfur Hexafluoride in Nonuniform Fields. *D. Berg, C. N. Works*, Westinghouse Research Laboratories. (Re-presented for Discussion.)

Solid-State Devices

CP58-820. Magnetic Frequency Dividers. *B. W. Glover*, The General Electric Co. Ltd.; *A. E. Maine*, The de Havilland Aircraft Co. of Canada.

CP58-821. A Nondestructive Breakdown Phenomenon in Selenium Rectifiers. *A. C. English, W. H. Tobin*, General Electric Co.

CP.* Determination of Drift Transistor Physical Parameters. *K. Y. Sih*, International Business Machines Research Lab.

CP58-822. Stability Criteria for Suppressing Thermal Runaway in Transistors. *R. B. Hurley*, Convair.

CP58-941. Recovery Time of Switching Transients in Silicon Diodes. *L. G. McPherson*, Westinghouse Electric Corp.

Friday, June 27

9:00 a.m. Morning Sessions

Communication Theory

58-538. The Analysis of Redundancy Networks. *F. Moskowitz*, Rome Air Development Center (Re-presented for Discussion.)

58-575. Operations Research in Communications. *B. Harris, A Hauptschein, L. S. Schwartz*, New York University. (Represented for Discussion.)

58-925. On Coding for the Binary Symmetric Channel. *A. B. Fontaine*, International Business Machines Corp.; *W. W. Peterson*, University of Florida.

CP.* The Relations between Coding Formats and Computer Structure. *J. H. Waite*, Radio Corp. of America.

Aircraft—A-C Systems

CP58-842. The Unique Generation System in the CF-100 Mark 5M Aircraft. *G. W. Handforth*, AVRO Aircraft Ltd.

CP58-834. Calculation of Steady-State Faults, Generator Excitation, and Fault Torques for Aircraft Systems by means of a Digital Computer. *J. B. Annable, H. A. Kahle, L. J. Stratton*, Jack & Heintz Inc.

58-918. Interrelationships among Fault Torque, Voltage Unbalance, Fault Current, and Generator Impedances of

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AIEE Memphis Section Officers

MEMPHIS SECTION OFFICERS for 1958-59, elected at the Section's Annual Dinner-Dance on June 13, 1958, are: (left to right) J. F. Fletcher, secretary; R. D. Barrett, 1957-58 chairman; J. H. Marable, director; G. D. Pollock, Jr., director; A. H. Beasley, chairman; and W. L. Wood, Jr., vice-chairman. Not shown are J. A. Blackburn, director; and L. E. Cox, treasurer.

Aircraft Electric Power Systems. *N. H. Jensen, R. T. Smith,* General Electric Co. (Re-presented for Discussion.)

58-848. **Co-ordination of Hydraulic Transmissions and Aircraft A-C Generators.** *S. C. Caldwell, T. E. Coppinger, R. T. Smith,* General Electric Co.

58-788. **Frequency Transient Measurements in Power Systems.** *G. N. Swanstrom,* Sundstrand Machine Tool Co.

Aircraft—Hi-Temp Design Considerations

58-790. **Progress in the Thermal Design of Oil-Cooled Rotating Electrical Machines.** *P. B. Richards,* Jack & Heintz, Inc.

58-919. **Prediction of the Thermal Behavior of Blast-Cooled Generators by Use of a Digital Computer.** *R. M. Moroney,* Massachusetts Institute of Technology.

58-857. **External Heat Transfer from Cylindrical Self-Cooled Electrical Equipment.** *D. Friedman,* U.S. Naval Research Lab.

CP58-920. **The Electric Analogue for Determining Temperature Distribution in Electrical Components.** *E. R. G. Eckert, J. P. Hartnett, T. F. Irvine, R. Birkebak,* University of Minnesota.

Hardware and Design of Feedback Control Systems

CP58-796. **Transfer Functions of Loaded Synchronous Machine.** *D. Hamdi-Sepen.* Technical University of Istanbul.

58-797. **Synthesis of Control Systems Based on an Approximation to a Third-Order System.** *C. R. Hausenbauer,* University of Arizona; *G. V. Lago,* University of Missouri.

CP58-798. **A 6-Watt Transistor Servo Amplifier for Operation from −55 C to +125 C.** *V. Vartanian,* Raytheon Mfg. Co.

CP58-799. **Linear Rate Generator.** *L. F. Stauder,* University of Notre Dame.

58-800. **The Design of Analog Computer Compensated Control Systems.** *S. C. Bigelow,* Columbia University.

Insulated Conductors

58-783. **The Vancouver 230-Kv Oil-Filled Cables.** *F. O. Wollaston, L. R. Horne,* B. C. Engineering Co., Ltd.

58-871. **Theory and Practice of Soil Densification.** *H. F. Winterkorn,* Princeton University.

Switchgear

CP58-960. **The Use of SF_6 in High-Voltage Interruption.** *R. E. Friedrich, G. Bates,* Westinghouse Electric Corp.

58-902. **Impulse System for Arc Recovery Strength Measurements.** *J. D. Cobine, E. E. Burger, G. A. Farrall,* General Electric Co.

58-825. **Advanced Interrupter Design for 230-Kv and 345-Kv Oil Circuit Breakers.** *W. R. Wilson, A. L. Streater,* General Electric Co.

CP58-943. **Influence of Linkage Flexibility on Dynamic Behavior of High Capacity Outdoor Circuit Breakers.** *P. Barkan, E. J. Tuohy,* General Electric Co.

2:00 p.m. Afternoon Sessions

Aircraft—Motors and Actuators

58-844. **Equivalent Circuits for 3-Phase 4-Wire Induction Motors Operating on Nonsymmetrical Systems.** *J. T. Mitchell,* Westinghouse Electric Corp.

CP58-833. **Design Parameters for Airborne Electric Motor Actuators.** *H. C. Zachmann.* The Martin Co.

CP58-838. **Electric Starting of Small Aircraft Gas Turbine Engines.** *C. D. Fearnot,* General Electric Co.

58-828. **Aircraft Switching Type Static Inverter Supplying Rotating Machines.** *K. M. Chirgwin,* Jack & Heintz, Inc.

CP.* **Determination of Intermittent Duty Rating of an Aircraft Motor by Equivalent Thermal Circuit and a Direct Analog Computer.** *J. N. C. Chi,* General Electric Co.

Aircraft—Parallel Systems

58-830. **Random Parelleling of Aircraft Alternators.** *F. P. deMello, H. M. Rustebakke,* General Electric Co.

CP58-921. **Transistorized Automatic Paralleling Circuit.** *A. W. Pratt,* Jack & Heintz, Inc.

58-922. **Analog Computer Simulation of an Aircraft Parallel A-C Generating System.** *M. Riaz,* Massachusetts Institute of Technology; *P. E. Smith, Jr.,* Conval Corp.

CP58-923. **Auxiliary Power Plant Operated in Parallel with Main Generators Martin *YP6M-1* Seamaster.** *G. O. Allen, P. J. Brennan, Jr.,* The Martin Co.

CP58-924. **The *YP6M-1* Seamaster 3-Generator Parallel A-C System.** *G. O. Allen,* The Martin Co.; *M. J. Powell,* General Electric Co.

Nonlinear Feedback Control Systems

CP58-804. **On the Nonextistence of Finite-Stage Zeroing Procedures for Certain Systems with On–Off Controls.** *B. A. Fleishman,* Rensselaer Polytechnic Institute; *B. Friedman,* University of California.

58-860. **Graphical Analysis and Synthesis of Feedback Control Systems—Part I: Theory and Analysis.** *D. Mitrovic,* University of Belgrade.

58-861. **Graphical Analysis and Synthesis of Feedback Control Systems—Part II: Synthesis.** *D. Mitrovic,* University of Belgrade.

58-862. **Graphical Analysis and Synthesis of Feedback Control Systems—Part III: Sampled-Data Feedback Control Systems.** *D. Mitrovic,* University of Belgrade.

58-852. **Multivariable Control System Syntthesis.** *R. J. Kavanaugh,* University of Toronto.

58-894. **A Novel and Simple Nonlinearized Control System.** *J. Zaborsky,* Washington University.

58-895. **Frequency Response of Nonlinear Closed-Loop Feedback Control Systems—***I. S. L. Mikhail,* University of California; *G. H. Fett,* University of Illinois.

58-771. **The Describing Function of Backlash Followed by a Deadzone.** *A. D. Gronner,* American Machine & Foundry Co.

Insulated Conductors

CP58-863. **Aluminum-Sheathed Paper-Insulated Cables.** *C. T. Hatcher, F. P. West,* Consolidated Edison Co. of N. Y. Inc.

CP.* **A Study of the Effects of Corona on Polyethylene.** *E. J. McMahon, D. E. Maloney, J. R. Perkins,* E. I. du Pont de Nemours & Co. (Inc.)

CP58-864. **An Investigation on Elastic Sheath Pressure Cables.** *N. Klein,* Israel Institute of Technology

Protective Relays and Transformers

58-789. **Magnetizing-Inrush Phenomena in Transformer Banks.** *W. K. Sonnemann, C. L. Wagner, G. D. Rockefeller,* Westinghouse Electric Corp.

58-818. **A Transformer Differential Relay with Second Harmonic Restraint.** *R. L. Sharp, W. E. Glassburn,* Westinghouse Electric Corp.

CP58-819. **Protection of Parallel 3-Terminal Transmission Lines.** *B. C. Hicks, A. B. Sturton,* Shawinigan Water & Power Co.

CIGRE Holds 17th Meeting in Paris, France, June 4-14, 1958

AT THE 17TH MEETING of the International Conference on Large Electric Systems (CIGRE), held in Paris, France, June 4-14, 1958, several major trends were evident.

First, for the first time there was complete freedom of international exchange, on the technical level, between East and West and among all the countries attending the Conference. The Soviet engineers, in particular, were able and willing to meet delegates from the United States, Great Britain, and elsewhere, alone or together, and it was obvious that they spoke with complete freedom.

Second, the various trends in power generation and the demand for energy, which have been distinguishable in recent years have not resulted in a diminution in the need for long-distance, high-power transmission of energy: the country with the most advanced nuclear program, Great Britain, showed in this connection that the transmission need would become even greater, while in other countries where the harnessing of more remote sources of power is on an ever-increasing scale, it was demonstrated that extrahigh-voltage power transmission over increasing distances has not a foreseeable limit. However, there was a salutary check to the bounding enthusiasm of some of the engineers in a speech by a British expert, who said that overhead lines in many cases were occupying more of the countryside than this particular public service had a right to expect.

Third, the use of high-voltage direct current for power transmission is now accepted as having its proper place, and as being a system sufficiently well proved to be considered on its technical and economic merits for any particular transmission project.

The number of registrations for this year's Conference, greater than ever before, reached almost 2,000. However, the repercussions of the political troubles in France immediately prior to the Conference meant that a number of delegates did not attend so that the actual attendance was slightly above CIGRE's figure of 1,750 reaching about 1,800.

One of the important sections of the CIGRE meeting dealt with developments at extrahigh voltage.

This group met under the chairmanship of Philip Sporn, president, American Electric Power Service Corp., who said that CIGRE had the advantage of providing the maximum international co-operation in this particular field, with the minimum cost and effort, by bringing together for entirely technical purposes in one place and at one time the leading experts from all parts of the world.

The special reporter of this section, F. Cahen, of France, stated that the questions in extrahigh-voltage development that appeared to be of the greatest interest could

be divided into three groups: the development of the utilization of extrahigh voltages, questions relating to internal overvoltages, and corona and radio interference problems.

The first speaker, F. J. Lane, of Great Britain, formerly in charge of the whole of the transmission network of the Central Electricity Generating Board, and now a consulting engineer, said that engineers should not presume too far on the essential nature of the service they provided. In many parts of the world, and in particular near large cities, the overhead line is already obtruding too greatly on society, and radio interference often has made its presence felt in far too great a degree. Mr. Lane mentioned several sites where as many as 20 overhead lines converged onto a substation. Judging by reports from America, Sweden, and other countries, he continued, this concern for preserving the countryside is felt in many parts of the world.

"The economic incentive to use the overhead line as much as possible is, however, a most important factor, which is understood by the public as well as by the engineer," stated Mr. Lane. "Yet," he continued, "it still remains one of the engineer's responsibilities to do his utmost within his own terms of reference to minimize the unobtrusiveness of overhead lines by restricting overvoltages, and improving insulation so as to reduce tower sizes; by proper regard for the appearance of structures; by making the maximum use of any line route that can be obtained (as by choice of higher voltage and preference for double circuit construction); and by selecting routes which make the least interference with the countryside."

The chief Soviet Union delegate, Mr. Lebedev, showed, in his remarks, that the USSR leads the world at the moment in regard to the actual use of the highest transmission voltage. At present, there are lines in that country working at 420 kv and the Soviets have made the interesting discovery that it is perfectly feasible to change to 500 kv by using the same towers and substation structures generally, radically changing only the autotransformers. In this way, they expected to achieve 40% more power transmission.

Speakers from both Britain and Sweden in presenting their reports showed that the influence of nuclear generation in their respective countries would not be likely, in any way, to decrease the need for transmission development.

The session then turned to consideration of the increase of the working voltage on existing systems. Perhaps the most interesting report was that from France, which showed how a 225-kv line embodying two separate circuits, each with single conductors, built 10 years ago, was converted to a single circuit 380-kv line with bundle conductors with two conductors per phase. This conversion has been extremely successful and delegates had the opportunity of seeing the Paris end of the line, which reaches to Gennisiat on the Rhone, a distance of 278 miles.

A paper from Canada by J. W. Simpson and V. E. Ogorodnikov of the Hydro-Electric Power Commission of Ontario, described the conversion of 115-kv lines to operate first at 230 kv and later at up to 262 kv.

A British delegate, Mr. Casson of the Central Electricity Generating Board, gave some interesting figures about the reasons behind the choice of 275 kv as the next voltage in the British grid system after over 20 years' operation with a 132-kv level. He said that converting a double circuit 132-kv line to a single circuit 275-kv line would double the power transmission rating, while a similar operation with a change of 275 kv to 380 kv would only increase the transfer capacity by 50%. He felt it would be better in all cases to reinforce by using a new line unless it was possible at least to double the amount of power that could be carried across a given route.

A subject touched on in this session and also in the generator session was that of the provision of a reactive power. It was thought undesirable to cause the reactive power requirements to be produced at the generators themselves. Mr. Lalander of the Swedish State Power Board expressed the view that it was too costly to transmit reactive power over great distances, and that he thought that capacitor banks should be used near the load centers to produce this power. In big stations synchronous condensers were preferred, and in Sweden they have decided to employ machines of this type of 100 mva capacity. In Great Britain, another delegate said, this view was also held but it had been decided in that country to use 40-mva capacitors for this purpose. The requirement for reactive power would be distributed over a large number of points in Britain.

Dealing further with this question of the improvement of the capacity of overhead lines, Dr. Burgsdorf of the USSR, said that when the first 400-kv lines in the Soviet Union were designed, the figure of three times the phase voltage was taken as representing the overvoltages likely to be encountered. Further research has shown that the system could be so organized in regard to the insulation levels that a figure of 2.5 times the phase voltage could now be taken as the basis for calculation.

On the question of corona and radio interference problems, the United States announcement that tests were to be carried out on lines operating up to 750 kv excited considerable interest. The most common method of countering radio interference is the use of bundle conductors, and two American contributions in this field were of special interest. Mr. Price, of the United States, said that radio interference in the last 10 years had received considerable attention, and it was still one of the most complex problems transmission engineers had to face.

The second contribution was made by A. R. Hard of the Washington State Institute of Technology. The use of twin or triple conductors implies severe mechanical problems caused by the necessity for employing spacers. His paper on the results of studies on conductor vibration on an outdoor test span under an actual transmission line on the Bonneville power

AIEE Materials Handling Conference

DURING THE AIEE Materials Handling Conference, May 19-20, 1958, in Pittsburgh, Pa., members participated in the Monongahela River inspection trip on the Dravo Corporation tow boat and U.S. Engineering barge. Approximately 85 men took this enjoyable and interesting trip up the river to view coal and ore bridge installations of the various steel companies located along the river.

system was well received, and in particular the film with which he accompanied it, showing for the first time slow motion pictures of extrahigh-voltage lines vibrating and twisting under snow release conditions, simulated by the dropping of sand bags. Mr. Hard also provided for the Conference an extremely useful survey of every existing type of spacer.

The German engineers in their report stated that the 4-bundle lines they had adopted for 380 kv working had given extremely low radio interference levels. The British reports concerning the twin-bundle 275-kv lines showed that while, in exceptional cases, there had been trouble the interference level was generally acceptable to the owners of radio and television sets even when the line passed within a few hundred yards of their residences.

The many detailed discussions in the other sections of the Conference, devoted to generators, transformers, circuit breakers, cables, and so forth, could be said, perhaps, to have brought forth less new material this year than in most other CIGRE years. It is, of course, understandable that electrical engineering on the heavy power side progresses continually but does not throw up definite new advances as often as once in 24 months. Nevertheless, some points of special interest emerged from the papers and discussions.

In the transformer field, perhaps the newest feature was seen in a paper by A. Lang of A.E.G. of Germany in which a d-c controlled reactor used as a transductor was advocated for high-voltage power transformer tap-changer application. The advantage would be the elimination of contacts since it is this feature of most tap changers which gives rise to most of the maintenance problems. However, the cost would be considerably in excess of the normal types of tap-changer which, in the course of a paper from Eire, were seen to have given reasonably reliable service over a period from 1937 to 1956 during which many types of tap-changer supplied by manufacturers in a number of countries were carefully watched for every kind of fault in operation. It appeared from this paper that although contact maintenance required the greatest amount of man-hours in time, the actual fault in operation principally arose from the driving mechanism or control equipment: indeed, about 90% of the faults arose from this feature.

An American contribution on transformer noise, by E. C. Wentz of Westinghouse Electric Corporation, was read with particular attention by British engineers who found that noise problems in residential areas had given them a good deal of trouble. It was stated by Mr. Wentz that most of the larger transformers are located on generating stations and on bulk supply transformer stations, where the residential areas are usually some distance from the site.

There was seen to be a growing tendency to use autotransformers for the interconnection of the new high voltage system with the remainder of the network. In the paper by W. Casson and G. B. Harper of Britain, an exhaustive survey was given of comparative designs of transformers submitted by different manufacturers.

The substation section suffered a little from lack of a common theme running through the papers, which dealt with widely divergent aspects of substation construction. It was, however, interesting to see for the first time at a CIGRE Conference, the papers from the People's Republic of China. These papers dealt with the prefabrication of concrete elements to make up high-voltage substations in which the minimum quantity of steel, whether for lattice work or for reinforcing, was required. In all cases, however, the papers appeared to take special note of the necessity for exercising the strictest economy in substation design, which had tended in the opinion of some delegates to get a little out of hand.

It was interesting to note that in a number of cases, the papers and the discussions indicated clearly the tendency toward bringing higher and higher voltages, in most cases by means of cables, right into the centers of towns and heavily loaded industrial areas.

The cable session was notable for the general acceptance of the need for d-c cables for submarine use.

Following the widespread dissemination of news about the Soviet trial installation of high-voltage d-c power transmission between Kashira and Moscow, the successful functioning over 4 years of the Sweden–Cotland scheme, and the decision to lay a d-c cable link across the Channel between England and France, there was mention of a number of other schemes involving submarine cables.

Perhaps the most interesting of these schemes was a proposal from Italy for a cable 82 miles long crossing the Adriatic Sea and linking the Yugoslav water power resources with the areas in the south of Italy where there is a power shortage. It was gathered, in the discussion, that this scheme is generally approved by both Yugoslav and Italian technicians and awaits only the agreement of the Yugoslav Government before practical plans could be prepared.

There is still room for argument as to the best form of submarine cable, whether for a-c or d-c use. For d-c, the choice so far has fallen on a paper impregnated cable of the solid type. A valuable paper by Mr. Gorodetzki of the USSR gave full details of service experience with a ±200-kv d-c cable and experimental experience with a ±400-kv cable, and in both cases comparisons were made between solid and oil-filled types. A British paper, by Mr. Mildner and Mr. Humphries of the Telegraph Construction & Maintenance Company, advocated the use of plastic-insulated cables for high voltage d-c, and the authors stated that a long program of experimental work had shown them that extruded plastic cables working at 200 kv to ground were perfectly practicable.

The growing extent of a-c submarine cable links was seen in the papers. A Japanese contribution indicated the use of an ingenious submarine plough to cut a channel below the surface of the bottom of the sea; many delegates brought forward methods of accurate location of submarine cables after laying; and there was much emphasis on the problems of corrosion of armouring, without reaching any definite conclusion as to the best method.

The most controversial point emerging from the cable session was the question as to whether continuous manufacture of the cable in one length is such an outstanding advantage as the British manufacturers who employ this method claimed in their contributions to the discussion. Cable makers from other firms, both from Britain and from other nations, said that with flexible joints now developed to the state of complete reliability continuous manufacture was not completely essential.

The switchgear section of CIGRE was not notable for any special new features, but when delegates visited the Plessis–Gassot substation (the Paris termination of the French 380-kv line from Gennissiat) they saw with considerable interest the suspended-type 380-kv, 13,000-mva minimum oil breakers, made by Ateliers de Constructions Electriques de Delle, France. This novel form of construction, which resulted in considerable economy in foundation work and in connection equipment, was also adopted for the extensive 225-kv substation from which the power received from the 380 kv-line was distributed.

Also on view at Plessis–Gassot was an experimental air-blast breaker (again by Delle) providing a breaking capacity of 25,000 kva, and suitable for 525-kv normal voltage.

CIGRE, 1958, showed again the value of international co-operation in the electrical field. It was, for example, particularly interesting to find American and Soviet engineers continuing their formal conference discussion exchanges outside the room, out in the street, and even over a glass in a Parisian cafe.

Plans Set for Western Joint Computer Conference

The 1959 Western Joint Computer Conference has been set for March 3-5 in San Francisco, Calif., according to an announcement by Dr. R. R. Johnson, general chairman. Headquarters and meeting place will be the Fairmont Hotel.

Joint sponsors of the Conference are the AIEE, Institute of Radio Engineers, and the Association for Computing Machinery.

The 3-day Conference, following the pattern of successful meetings alternating between San Francisco and Los Angeles during the past 5 years, will draw an attendance of more than 1,200 engineers and management people. The theme set for the program is "New Horizons with Computer Technology."

Dr. Johnson, who is manager of the General Electric Computer Laboratory at Palo Alto, Calif., also announced the appointment of Dr. M. L. Lesser of the IBM Research Laboratory, San Jose, Calif., as chairman of the Technical Program Committee. Dr. Lesser, in inviting program participation in the Conference, has indicated that, in keeping with the theme, there is to be particular emphasis on factual papers dealing with the newer applications of computer techniques, such as information retrieval, operation control, pattern analysis, decision making, computer communications, and learning concepts, as well as on papers dealing with

advances in computer component and systems design.

Correspondence concerning the Conference is to be addressed to Box 381, Station A, Palo Alto, Calif.

"Biology and Computers" Will Be Theme of Conference

The 11th Annual Conference on Electrical Techniques in Medicine and Biology will be held in Minneapolis, Minn., November 19-21, 1958, at the Nicollet Hotel. It is sponsored by the AIEE, Institute of Radio Engineers (IRE), and the Instrument Society of America (ISA) through their Joint Executive Committee on Medicine and Biology.

This year, the Conference has adopted the policy of having a principal theme for the entire meeting—"Biology and Computers." This theme is of very special current interest because of the many new avenues of research and development in medicine and biology which have been opened up through the increasing availability of electronic computers and computer techniques. Of less widely realized but perhaps greater importance is the possibility of greatly improving the performance, efficiency, and compactness as well as greatly extending the scope of electronic computers through utilization of knowledge regarding the computer-like systems that reside in animals and plants. These developments are especially important in connection with instrumentation for space vehicles.

One special session will examine the possibilities of applying electronic computers to the theoretical and clinical problems of electrocardiography. This field has enjoyed a sudden increase in interest since it has been realized that machine analysis and possibly even partial electrocardiographic diagnosis of heart disease may become a reality in the near future. Also examined will be the many ways in which the physician may be aided in making his diagnosis rapidly and accurately through the use of electronic computers.

Another special session will be devoted to computer ideas as applied to electroencephalography, popularly called brainwave analysis. There are numerous scientific hints at the moment that through examining the electric field within the brain and on the surface of the head, much can be learned regarding the processes of the brain, both normal and abnormal. Several different means for analyzing this data are already being planned and tested and will be compared and discussed at this meeting.

A third special session will be devoted to the unfamiliar but fascinating inverse problem of developing computer applications on the basis of biological coding, biological transducer designs, and biological logic. In this session, computer engineering will be profiting from biology instead of biology from engineering.

In each of the sessions the group of invited speakers will be chosen from among the outstanding workers in the field and will be well qualified to present a well-rounded picture of recent advances.

There will also be sessions of shorter contributed papers in any area of electronics as applied to biology and medicine. Abstracts are invited from all who may care to participate, the number accepted being limited only by the available time.

The meeting is open to all scientists, engineers, and physicians who may care to attend and student attendance is encouraged through a reduced registration fee.

Membership of the joint Executive Committee for Medicine and Biology from the AIEE, the IRE (and its Professional Group on Medical Electronics), and the ISA is as follows: L. G. Cummings (IRE), L. E. Flory (IRE), R. S. Gardner (AIEE), W. Greatbatch (IRE), D. A. Holoday (ISA), H. S. Kindler (ISA), G. C. Riggle (AIEE), H. P. Schwan (AIEE), R. H. Tripp (ISA), and O. H. Schmitt (IRE) chairman.

Membership of the Eleventh Annual Conference Committee is as follows: E. E. Bakken, Medtronic, Minneapolis, Minn., publicity; Robert Erskine, Minneapolis-Honeywell, Minneapolis, Minn., treasurer; J. F. Herrick, Mayo Foundation, University of Minnesota, program; T. J. Pierce, Alfred Crossly Associates, St. Paul, Minn., local arrangements; H. O. Schuck, Minneapolis Honeywell, Minneapolis, Minn., local publicity; O. H. Schmitt, Department of Biophysics, University of Minnesota, Conference chairman.

Abstracts of 250 words for short contributed papers offered for inclusion in the program may be sent by October 1st to Robert Erskine, Minneapolis-Honeywell, 2753 Fourth Ave., South, Minneapolis, Minn. Registration forms for advance registration and for hotel reservations may also be obtained from him.

AIEE No. 1—General Principles Upon Which Temperature Limits are Based in the Rating of Electrical Equipment

It has come to the attention of the AIEE Standards Committee that some misunderstandings have arisen concerning the proper interpretation of AIEE No. 1, June 1957, among various individuals, and in technical committees, who are responsible for the preparation of equipment standards.

The question is whether equipment standards that specify temperature rises based on limiting temperatures higher than the values shown in Table 1-16 will be considered contrary to the intent of AIEE No. 1. The answer to this question is that now, as in the past, the committees preparing equipment standards are free to choose limiting temperatures and temperature rises as may be needed to suit their particular requirements.

In the revision of AIEE No. 1, there was no intention of changing its long-time purpose to serve as a guide for the preparation of standards. The temperatures and other provisions given therein are not intended to be used for rating or testing equipment for which specific AIEE, American, or other recognized standards are available. Also, there are a number of statements in the text to the effect that committees preparing equipment standards should be guided by experience and by economic and other pertinent factors in selecting temperature limits for a particular type of equipment.

The question of interpretation has arisen because the definitions of insulating material classes, which have for many years been designated by certain letters of the alphabet, now are given alternative class designations in degrees C. These degrees C designations are nominal temperatures and were intended eventually to supersede the class letter designations because of the need for adding new classes with letters not in alphabetical order.

AIEE Co-ordinating Committee No. 4, which is responsible for the periodic revision of AIEE No. 1, is aware of the questions that have been raised and will in the next revision make changes that may be necessary to remove the possibility of misinterpretation.

(Prepared in accordance with action of the Standards Committee, June 4, 1958.)

World Power Conference Meets in Canada for First Time

Energy in all its aspects—hydraulic, thermal, nuclear, and even solar—will be under close study for 4 days in Montreal, Que., Canada, during September, as experts from 50 different nations gather for the World Power Conference.

Meeting in Canada for the first time in its history, the Conference will receive some 150 papers under 3 main divisions: production, transportation, and utilization. Presenting them will be scientists, engineers, economists, and other experts representing most of the Conference's 52 member countries.

Conference sessions on topics chosen for discussion and debate will open on Monday, September 8. That morning will be devoted to hydraulic energy, covering both system planning and design and operation. In the afternoon, an estimated 1,000 delegates expected to attend the gathering will discuss the more general aspects of hydraulic energy, including economic trends in power development.

Tuesday morning's sessions will consider production of thermal energy from coal, oil, and gaseous fuels, and delegates will turn their attention that afternoon to nuclear energy and nuclear fuels.

On Wednesday morning, September 10, sessions on transportation will open, with global trends in electric transmission and in carriage of fuel by rail, water, and pipeline all being examined.

Sessions on utilization will begin on Wednesday afternoon, as Conference dele-

gates meet to review the use of power in industry and commerce. They will continue the following morning, Thursday, as the 4-day meeting ends with discussions covering utilization of power on the farm, in the home, and by railways and airlines.

To be held at The Queen Elizabeth in Montreal, the Canadian meeting will be the 15th in the history of the World Power Conference, and only the second to be staged in North America. It has involved 2 years of detailed planning, and will be one of the largest meetings of its kind ever held.

None of the papers to be presented will actually be read at the meeting, according to Major General H. A. Young, Canada's Deputy Minister of Public Works and chairman of the Canadian Committee. Instead, preprints will be distributed in advance to the delegates, and sessions will consist of reviews of the papers prepared by general Conference reporters and of discussion and debate on selected topics of interest.

Over-all conference theme will be "Economic Trends in the Production, Transportation, and Utilization of Fuel and Energy."

Committee for 1959 Winter General Meeting

The following have been appointed to the AIEE 1959 Winter General Meeting Committee: R. T. Weil, Jr., chairman; R. W. Gillette, vice-chairman; J. J. Anderson, secretary; D. M. Quick, ex-officio; J. R. Kerner, budget co-ordination; C. T. Hatcher, technical program; J. A. Parrott, public relations; W. T. Rea, general session; D. E. Winslow, hotel accommodations; T. C. Oliver, registration; H. G. Koch, inspection trips; Arvin Gravel, monitors; D. Halloran, smoker; E. J. Doyle, dinner–dance; Mrs. D. M. Quick, ladies program.

The usual registration fee of $5 for members and $8 for nonmembers will obtain for the duration of the meeting except that the Board of Directors has approved a one-day registration fee of $2 for both members and nonmembers on an experimental basis.

Technical Discussions at Maine Section Annual Meeting

The Maine Section of the AIEE held its fourth annual afternoon and evening meeting at Sebasco Estates, Phippsburg, Maine, on June 11, 1958. Attendance was approximately 110 including over 30 women guests.

The afternoon session included three technical discussions as follows: "Are Engineers Professional People," by J. W. Rittenhouse, Hi-Voltage Equipment Company; "Process Control with the Radiation Gauge," illustrated by E. W. Carpenter, Industrial Nucleonics Corporation; and "Application of Electronic Data Processing Machines to Engineering Problems," explained by L. J. Rankine, International Business Machines Corporation.

The ladies were shown colored slides of Florida and New England by Miss Esther Thorpe of Auburn, after which many of the ladies enjoyed a boat ride on Casco Bay.

Following the social hour and dinner, J. W. May of the I-T-E Circuit Breaker Company presented an illustrated lecture on "USSR in 1957."

October 1 Is Deadline for Nuclear Congress Paper Outlines

Engineers and scientists who would like to present technical papers during the Fifth Nuclear Congress, to be held in Cleveland, Ohio, April 5-10, 1959, should submit outlines before October 1, 1958.

As in the past, the Congress will be composed of four parts: The Nuclear Engineering and Science Conference, the Hot Laboratories and Equipment Conference, the Atomic Energy Management Conference, and the AtomFair at which nuclear equipment will be on display. The Congress will be held at the Cleveland Auditorium.

Clarke Williams of Brookhaven National Laboratory, chairman of the Nuclear Engineering and Science Conference, announced that papers will be considered for inclusion in the 1959 program if summaries are submitted before October 1, 1958. He stated that prospective authors should submit 300 to 500 word summaries of proposed papers to the secretary of any one of the sponsoring societies. A list of sponsoring groups is available from Engineers Joint Council, 29 W. 39 St., New York, N.Y.

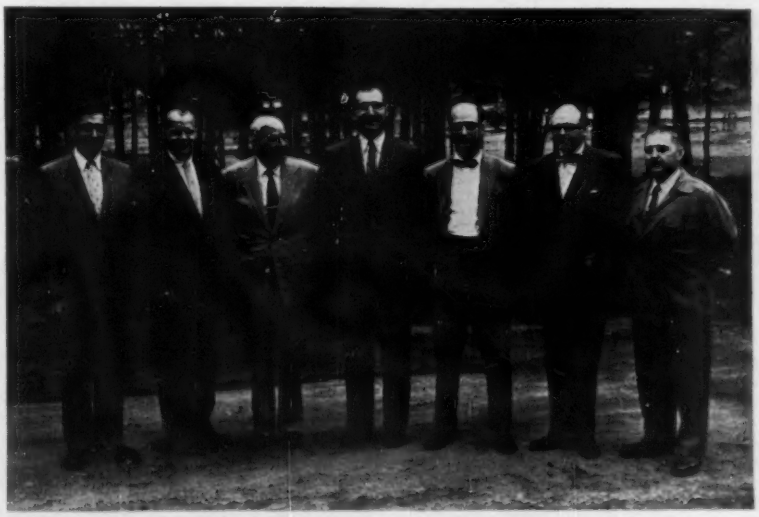
Mr. Williams added that papers selected will be those presenting the most recent and outstanding developments in the nuclear field. Topics in the past have included reactor design, power plants, radiation techniques, instrumentation, shielding, waste disposal, and related items.

The sponsoring organizations are: AIEE, American Chemical Society, American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Institute of Industrial Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Nuclear Society, The American Public Health Association, American Rocket Society, American Society of Agricultural Engineers, American Society of Civil Engineers, American Society for Engineering Education, American Society of Heating and Air-Conditioning Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, American Water Works Association, American Welding Society, Atomic Industrial Forum, The Engineering Institute of Canada, Federation of Sewage and Industrial Wastes Association, Health Physics Society, Hot Laboratory Committee, Institute of Aeronautical Sciences, Institute of Radio Engineers, Instrument Society of America, National Industrial Conference Board, Society of American Military Engineers, Society of Automotive Engineers, Society of Naval Architects and Marine Engineers.

For general information on the Congress, contact: T. A. Marshall, Jr. (Congress manager), or L. K. Wheelock (assistant manager), c/o Engineers Joint Council, 29 W. 39th St., New York 18, N.Y.

AIEE and NEMA Sponsor New ASA Sectional Committees

The formation of two new committees for the development of American Standards in the electrical field have been approved by the American Standards Association (ASA), it was announced by J. W. McNair, technical director of the ASA.



AIEE MAINE SECTION OFFICERS for 1958-59 are: (*left to right*) R. L. Thorpe, assistant program chairman; F. A. Smith, program chairman; B. T. Payne, assistant secretary-treasurer; C. E. Monty, outgoing chairman; W. W. Turner, vice-chairman; G. F. Hart, secretary-treasurer; and L. W. Burr, chairman.

ASA Sectional Committee C92, on Insulation Co-ordination will be sponsored jointly by the AIEE and the National Electrical Manufacturers Association (NEMA).

ASA Sectional Committee C93, sponsored by the same two organizations, will be concerned with coupling capacitors, coupling capacitor potential devices, and line traps.

The formation of these new committees is now under way.

The scope of Sectional Committee C92 has tentatively been approved as follows:

1. To study problems of co-ordination of insulation strengths of the different types of apparatus used in electrical systems.

2. To develop co-ordinated minimum values for the external dielectric requirements of outdoor apparatus for power transmission and distribution, as follows: (a) wet and dry low-frequency withstand test levels, (b) impulse withstand test levels, (c) altitude correction factors, (d) minimum creepage distance on insulation exposed to the weather.

3. To compile data to prepare guiding principles for the use of Sectional Committees with respect to requirements for insulation strengths of various types of apparatus.

4. To assure the co-ordination of American and international standards.

The scope of Sectional Committee 93 has tentatively been approved as follows:

"Standards, specifications, methods of test, and definitions for coupling capacitors, coupling capacitor potential devices, and line traps for electric power lines."

In accordance with the procedures of the American Standards Association, any group or organization substantially concerned with the scope of a standards project may be represented on the sectional committee concerned with the development of the standard.

Call for Papers for Solid-State Circuits Conference

The 1959 Solid-State Circuits Conference, sponsored by the AIEE Committee on Electronics, Institute of Radio Engineers (IRE) Professional Group on Circuit Theory, IRE and AIEE Philadelphia Sections, and the University of Pennsylvania, will be held on February 12-13, 1959, in Philadelphia, Pa.

The Conference has, in the course of its history, developed into a major annual technical event. Originally devoted to transistor circuit technology, the Conference, in recent years, has broadened its field of coverage to include applications and circuit techniques of a great variety of solid-state devices. Plans for the 1959 Conference call for the presentation of papers dealing with circuit properties of, and circuit philosophy and techniques related to solid-state devices in the following general areas: (1) novel semiconductor devices and conventional semiconductor devices in novel modes of operation; (2) significant contributions to the transistor circuit art (to the exclusion of design detail and gadget-type papers); (3) solid-state devices performing an integrated circuit function (such as single devices capable of counting, converting from digital to analog mode of operation, etc.); (4) solid-state microwave devices and amplifying mechanisms (such as parametric amplifiers, masers, etc.); (5) solid-state memory, storage, and logic devices (such as twistors and thin film memories and associated circuits, optoelectronic logic, etc.); (6) low temperature digital and linear applications; and (7) novel types of solid-state devices (such as Hall-effect devices, solid-state filters and delay lines, high temperature circuit elements).

Papers representing original contributions in these and related fields are solicited for presentation at the Conference. It should be emphasized that the papers presented at this Conference should be circuit and application oriented. Abstracts of 200 or more words explaining clearly the nature of the contribution, its significance, the novelty of theoretical and experimental results should be sent no later than October 16, 1958, to: A. P. Stern, Program Committee Chairman, 1959 Solid-State Circuits Conference, General Electric Company, Electronics Park, Building 3—Room 113, Syracuse, N.Y.

Federal Approval of ESPS Job Recruitment

Recruitment of Engineers for Federal Agencies through the Engineering Societies Personnel Service, Inc., now approved by the United States Civil Service Commission.

A new policy, as set forth in the United States Civil Service Commission's Departmental Circular No. 949, now permits the use of certain employment agencies and specifically mentions only the Engineering Societies Personnel Service (ESPS), a nonprofit service sponsored by eight engineering societies, as an example of a nonprofit professionally sponsored employment service under this new recruitment program to recruit engineers and scientists for Federal Agencies.

The policy is designed specifically to make available to Federal Agencies another means of attracting applicants to hard-to-fill engineering and scientific positions. It makes available to governmental agencies the extensive local, regional, and national coverage extended by the Societies through ESPS. In order to preserve the basic principle that no one shall be required to pay a fee to secure Federal employment, each agency will make its own arrangements and execute its own agreement to pay to the participating employment services any fees charged for successful placement under this program. Agencies should determine that they have the legal authority to use their funds for these purposes before participating in the program.

This now means that an applicant may receive a Federal position without the payment of any fee since the payment of the ESPS fee will be paid for by the Government Agency.

Lamme Medal Nominations Must Be Submitted by December 1

Members of the Institute again are reminded that they have an opportunity to submit nominations for the 1958 Lamme Medal. All nominations must be received not later than December 1, 1958.

Details regarding qualifications for the award were published in the June 1958 issue of *Electrical Engineering*, p. 531.

It permits ESPS to render the same assistance to governmental agencies as it has provided to private employers for the past 40 years.

The Engineering Societies Personnel Service, Inc. (ESPS), sponsored by and co-operating with the AIEE, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, has offices at 8 W. 40th St., New York 18, N.Y., 100 Farnsworth Ave., Detroit 2, Mich., 84 E. Randolph St., Chicago 1, Ill., and 57 Post St., San Francisco 4, Calif.

AIEE Power Industry Computer Application Conference

The AIEE Power Industry Computer Application Conference will be held in Toronto, Ont., Canada, September 15-17, 1958, at the King Edward Hotel.

Although several papers have been presented on the subject over the last few years, this is to be the first International Conference held in America which will deal specifically with digital computer applications devoted to the power industry.

The Conference is to be divided into the following five sections, with speakers who are well-known authorities in this particular field.

1. *Design of Rotating Machinery*—Including induction motors, synchronous motors, and turbine generators, and the analysis of transient performance of such machines.

2. *Design of Nonrotating Machinery*—Problems associated with transformers, reactors, and rectifiers.

3. *Electric Power System Analysis and Design*—Studies on power flow and voltage levels, short-circuit currents, stability, and transmission line tower design.

4. *Power System Operating Problems*—Power system operating problems such as generation reserve and interconnection requirements, economic dispatching including hydrothermal systems, and generator pull-out characteristics.

5. *Power System Economic Studies*—Forecasting system loads, estimating production expenses, and distribution system design.

Interesting inspection trips will be made to visit typical computer installations in the Toronto area.

For further information on registration and hotel accommodations, write J. R.

Leslie, c/o Ontario Hydro, 620 University Ave., Toronto, Ont. Canada.

The tentative technical program for the Conference follows.

Monday, September 15

8:30 a.m. Registration

10:00 a.m. Application of Computers to Electric Power Systems

Presiding: F. L. Lawton, Aluminum Laboratories, Ltd.

Welcome to Toronto: W. R. Strike, vice-chairman of Hydro-Electric Commission of Ontario

Preview of Conference Program: L. B. LeVesconte, Sargent & Lundy, Engineers

Introduction to Computers: F. J. Maginniss, General Electric Company

58-1084 The Use of Compiler Programs To Solve Power System Problems on a Large Digital Computer. *J. T. Carleton, C. J. Baldwin, Jr.*, Westinghouse Electric Corporation

58-1085 The IBM-650 as a Tool for Analysis of Transmission and Distribution System Problems. *G. E. Adams, J. E. Gerngross*, General Electric Company

12:30 Luncheon

2:00 p.m. Economic Studies of Electric Power System.

Presiding: G. D. Floyd (Toronto Section), Hydro-Electric Power Commission of Ontario

CP* Applications of Ferranti Computers to the Design and Operation of Electrical Power Equipment. *Prof. M. W. Humphrey Davies, P. P. Gupta*, Queen Mary College, London, England

CP58-1086 Power System Studies Made on Univac. *Vince Converti*, Arizona Public Service Company

CP58-1104 The Royal-McBee *LGP-30* Computer Solution of Electrical Load Flow. *H. W. Osterle*, West Penn Power Co.; *Mel Kaye*, Royal-McBee Corp.

CP58-1087 The Digital Computer as a Tool in Estimating Electric Power Production Expenses for Future Conditions. *R. A. Markel, W. C. Marble*, Philadelphia Electric Company

58-1088 Digital Computer Applied to Electrical Distribution System Planning. *E. A. Strausser*, Engineers, Inc., Patterson & Dewar

Tuesday, September 16

9:00 a.m. Design and Analysis of Rotating Machinery

Presiding: C. G. Veinott (Rotating Machinery Committee), Reliance Electric & Engineering Company

58-1089 Experience in Using a High-Speed Computer in the Design of Large Turbine Generators. *Dean Harrington, N. H. Larney*, General Electric Company

58-1090 Design of Armature Coils for Large A-C Motors by Means of High-Speed Digital Computer (Univac). *R. M. Sexton, S. A. Balik*, Westinghouse Electric Corporation

58-1091 Digital Computation of Synchronous Generator Pull-Out Characteristics. *W. F. Cawson, H. E. Brown*, Commonwealth Edison Company

CP58-1092 Synchronous Machine Design Using a Digital Computer. *M. Anantha Pai, R. M. Saunders*, University of California

58-1093 Digital Computer Solution of Distributed Parameter Problems in Electrical Machinery. *D. T. Bewley, L. M. Harvey* General Electric Company

* Conference papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

Jones & Morris Commercial Photographers

AMERICAN AND CANADIAN ENGINEERS planning for the AIEE Power Industry Computer Application Conference, to be held at the King Edward Hotel in Toronto, Ont., Canada, September 15-17, 1958, include: *(seated, left to right)* J. T. Fisher, Bell Telephone, Toronto; J. R. Leslie, Ontario Hydro, Toronto; George Fraser, G. M. Fraser, Toronto; Fred Heath, CGE, Toronto; G. R. Slemin, University of Toronto; E. A. Ricker, Ontario Hydro, Toronto; J. Aitchison, IBM, Toronto; L. B. LeVesconte, Sargent & Lundy, Chicago, Ill.; F. J. Maginniss, General Electric Company, Schenectady, N. Y.; F. L. Lawton, Aluminium Laboratories, Montreal; R. M. Clark, CNT, Toronto; *(standing, left to right)* H. R. Davis, CNT, Toronto; R. B. Steele, CNT, Toronto; R. J. West, CLM, H. M. Sweezie, TTC, Toronto; F. M. Longstaff, Ferranti, Toronto.

2:00 p.m. Inspection Trips

6:30 p.m. Dinner

Speaker: Prof. Marcus Long, University of Toronto

Wednesday, September 17

9:00 a.m. Static Components of the Electric Power System

Presiding R. J. Brown (Transfers Committee), Moloney Electric Company of Canada, Ltd.

58-1094 Complete Design of Power Transformers with a Large-Size Digital Computer. *S. B. Williams, P. A. Abetti, H. J. Mason*, General Electric Company

58-1095 Power Transformer Design and Estimate Cost Program with an IBM *650* Digital Computer. *L. J. MacKinnon*, Canadian General Electric Company, Ltd.

CP58-1096 Sag-Tension Calculation Program for Digital Computer. *B. M. Pickens*, Anaconda Wire & Cable Company

58-1097 Digital Calculation of Overhead Transmission Line Constants. *Dorothy Coleman, Floyd Watts, R. B. Shipley*. TVA

58-1098 Calculation of Transmission Line Impedance by Digital Computer. *A. O. Thomas*, Penn Power & Light Company

12:00 Noon Luncheon

2:00 p.m. Analysis of Electric Power Systems

Presiding: L. B. LeVesconte (System Engineering Committee), Sargent & Lundy, engineers

58-1099 Digital Calculation of Power System Networks Under Faulted Conditions. *R. T. Byerly, R. W. Long, C. J. Baldwin, C. W. King*, Westinghouse Electric Corporation

58-1100 Experience in Computation of Load-Flow Studies, Using High-Speed Computers. *H. P. St. Clair, G. W. Stagg*, American Electric Power Service Corp.

58-1101 Transient Stability Studies II Automatic Digital Computation. *C. M. Lane, R. W. Long, J. N. Powers*, Westinghouse Electric Corporation

CP-58-1102 New Automatic Program for Load Flow Studies on the IBM *704.* *Mrs. M. S. Dyrkacz, F. J. Maginniss*, General Electric Company

CP58-1103 Digital Computer Control of Interconnected Power Systems. *Dr. A. P. deQuervain Brown*, Boveri & Company

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Copies of CP58-243, "Preliminary Report on Survey of Electric Utility Applications of Digital Computers," may be obtained by sending order and remittance to the AIEE Order Department, 33 W. 39th St., New York 18, N. Y., price 40¢ to members: 80¢ to nonmembers. This preliminary report tabulates the results of a questionnaire regarding digital computer programs for the solution of electric utility engineering problems.

PREPRINT PRICES

40¢ to Members
80¢ to Nonmembers

MINIMUM ORDER by mail $1.20 unless accompanied by remittance or coupons. All nonmember orders *must* be accompanied by remittance.

COUPON BOOKS in ten-dollar denominations may be purchased.

NUMBERED PAPERS only are available.

SEND ORDER and remittance to:
AIEE Order Department
33 West 39th Street,
New York 18, N.Y.

AIEE Acts as Sponsor of ASA Project

Agreement on a national bushing standard covering the most prevalent voltages used on power circuit breakers and outdoor transformers provides the electrical industry with a potential for vast savings. This is the new American Standard, C76.1a-1958, Outdoor Apparatus Bushings.

The standard was worked out and agreement obtained by a voluntary national standards committee designated as C76. Organized and operating in accordance with the procedures of the American Standards Association (ASA), the committee is composed of representatives of manufacturer and user groups. American Standard C76.1a establishes standard electrical and dimensional characteristics for application of apparatus bushings within the range 23 kv through 196 kv. Administrative sponsor of the project is the AIEE.

The chairman and secretary of C76 are J. R. North of Commonwealth Associates, Inc., Jackson, Mich., and H. P. Pinkham, Allis-Chalmers Manufacturing Company, Boston, Mass., respectively. Following are their comments on this new standard.

Prior to the development of this standard, it has been largely by accident that any bushing of a given kv and ampere rating from one piece of apparatus would fit another of the same rating. This condition has created a serious problem in the matter of spare units for replacement. Power companies have been forced either to maintain large inactive bushing inventories, or in emergency to seek quick delivery on special items of manufacture.

As a direct result of the development of the new C76.1a bushing standard, there will only be 36 American Standard bushing sizes all the way from 23 kv through 196 kv, including both transformers and circuit breakers. Although it is likely that a number of specials may still be manufactured on request, the new American Standard will reduce greatly the more than 2,000 individual items of bushings heretofore used in the 23-kv to 196-kv range. Hundreds of spare bushings have accumulated in stock and some have been scrapped without a day of service when the "parent" piece of apparatus was retired. It is estimated that companies supplying electricity will save thousands of dollars annually from the reduction in spare bushing inventories required, and the greater flexibility in utilization of spare bushings. The complications in the way of achieving such co-ordination were great and a most careful review of many engineering considerations was necessary.

There have been many questions concerning the immediate relief which the bushing standard will provide. Naturally, thousands of transformers and circuit breakers presently in service, with their accompanying thousands of different bushings, will remain in use for the next 20 to 30 years. Fortunately, however, the trend of all new designs of bushings is in the direction of reduced cardinal dimensions, and the new American Standard bushings will fit into the mounting holes of older apparatus—usually with room to spare. Some adaptations may be necessary, but these will consist of relatively inexpensive fabricated metal parts that can either be stocked or obtained locally on short notice.

Under the new standard, there will be greater freedom for the buyer with little limitation to any single make of apparatus or bushing, since standard bushings of a given rating are interchangeable. Costs will be more easily controlled and lower ultimate costs and improved deliveries will be reflected in apparatus and component procurement.

Specification of American Standard C76 bushings on all new station equipment is expected to provide economies in many areas. C76.1a is available for purchase at 50¢ by writing to the American Standards Association, 70 E. 45 St., New York 17, N. Y.

The work of the ASA Sectional Committee is far from completed. There are yet many areas where more standardization will result in manufacturer and user economies. The year 1958 promises still further voluntary and effective standards for bushings.

E. D. Barcus New Chairman of AIEE Los Angeles Section

E. D. Barcus, Pacific Telephone and Telegraph Co., has been elected chairman of the AIEE Los Angeles Section for the year 1958-59. The announcement was made by H. A. Lott, outgoing chairman, at the annual "Ladies' Night" banquet.

Mr. Barcus, a graduate of the California Institute of Technology, is a registered professional electrical engineer, and served last year as vice-chairman of the Los Angeles Section. In Pacific Telephone and Telegraph Co., he heads the Toll Service Transmission Engineering organization.

Recent changes in the Los Angeles Section Bylaws have streamlined the organization so that only the chairman, vice-chairman, secretary-treasurer, and the four directors were elected by ballot. Those elected at this time in addition to Mr. Barcus are—Vice-Chairman: Fred Foulon, electronics research engineer, Douglas Aircraft Company, El Segundo; Secretary-Treasurer: Robert Milmoe, supervising engineer, Bechtel Corporation; Director #1—Professional Development and Recognition: F. L. Goss, Los Angeles Department of Water and Power; Director #2—Technical Operations: Alan Capon, City of Burbank; Director #3—Technical Operations: L. L. Grandi, University of California at Los Angeles; Director #4—Administration: H. H. Mitchell, Kelman Electric and Manufacturing Company.

Division chairman will be chosen by their own groups and committee chairmen and committee members will be appointed.

New Officers of NSPE Announced

Dr. C. A. Dunn, of Stillwater, Okla., has been elected president of the National Society of Professional Engineers (NSPE).

A professor of civil engineering and executive director of the office of Engineering Research at Oklahoma State University, Dr. Dunn succeeds G. H. Dyer, of Independence, Mo., as head of the 46,000-member engineering group.

Dr. Dunn is a past president of the Oklahoma Society of Professional Engineers, and has served two terms as vice-president of the NSPE's Southwestern Region.

Six regional vice-presidents and a treasurer were also elected for the administrative year which began in July 1958. The new vice-presidents are: H. A. Mosher, Rochester, N.Y., Northeastern Region; J. B. McGaughy, Norfolk, Va., Southeastern Region; L. E. Easley, Indianapolis, Ind., Central Region; W. L. Hindermann, St. Paul, Minn., North Central Region; L. R. Durkee, Seattle, Wash., Western Region; and N. E. Hull, Houston, Texas, Southwestern Region. R. B. Allen, College Park, Md., was elected for his 11th term as treasurer.

AIEE PERSONALITIES

L. M. Goldsmith (M '26, F '47), general manager, engineering and construction department, The Atlantic Refining Company, Philadelphia, Pa., has retired after 42 years with the firm. Dr. Goldsmith is well known for his many engineering contributions to the petroleum industry. He successfully pioneered the application of electric welding in the construction of pipelines and ocean-going tankers. He engineered the development of the first high-pressure, high-temperature turbine electric steamship and was later responsible for the world's first class of 30,000 dead weight ton supertankers used in the oil industry. During World War II, he served as an expert consultant to the War Department and was loaned to the British Ministry of War to participate in the development of their project PLUTO, by which flexible pipelines were successfully extended across the English Channel to supply petroleum products to the allied forces in France. He received the U. S. Army Exceptional Civilian Service Medal and the Presidential Certificate of Merit for his services during World War II. Dr. Goldsmith has served on the following AIEE Committees: Marine Transportation (1941-58); Chemical, Electrochemical, and Electrothermal Applications (1947-51); and Petroleum Industry (1954-57).

W. B. Swift (AM '51), assistant professor of electrical engineering, University of Wisconsin, Madison, Wis., has received the Kiekhofer Memorial Teaching Award which is given annually to outstanding young Wisconsin faculty members for excellence in teaching.

W. W. Renberg (AM '52), technical product leader in charge of shell-form power transformers, engineering department, Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa., has been appointed assistant sales manager.

E. W. Wilson (AM '51), electrical engineer, Design Section, B. F. Goodrich Chemical Company, Cleveland, Ohio, has been named maintenance foreman of the company's general chemicals plant in Henry, Ill. Mr. Wilson is a member of the American Society of Mechanical Engineers.

Paul Pittman (AM '57) has been appointed supervising engineer of the Solid-State Electronics Application Section of the materials engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.

R. E. Robertson (AM '53), assistant project manager, Hughes Aircraft Company, Culver City, Calif., has been appointed chief engineer of B&H Instrument Co., Inc., Fort Worth, Texas.

L. J. Berberich (AM '30, F '45), acting manager of the Insulation and Chemical Development Section, materials engineering department, Westinghouse Electric Corporation, has been named manager, engineering department, Associated Companies Division, Westinghouse International Company, East Pittsburgh, Pa. Dr. Berberich has been active in the AIEE as chairman of the Pittsburgh Section. He has served on the following Institute Committees: Research (1937-40); Basic Sciences (1951-57, chairman 1954-55); Rotating Machinery (1951-53); Dielectrics (chairman 1955-58); and Science and Electronics Division (1954-58).

E. W. Henderson (AM '08, M '29), manager, rotating equipment engineering and design, English Electric Co. of Canada, Ltd., St. Catharines, Ont., Canada, has retired after 24 years of service with the company. Mr. Henderson was chairman of the Cleveland Section of the Institute (1928-29) and served on the AIEE General Power Applications Committee (1925-30) and Electrical Machinery Committee (1931-33, 1936-38). He was Canada's official delegate at the International Electrotechnical Commission meeting in Stockholm, Sweden, during July 1958.

A. H. Scott (AM '42, M '48), physicist, National Bureau of Standards, Washington, D. C., has received an award of merit from the American Society for Testing Materials (ASTM) in recognition of intelligent leadership and unfailing energy supporting the activities of Committee D-9 on Electrical Insulating Materials, advancing the standing of the ASTM nationally and internationally. Mr. Scott has served on the AIEE Dielectrics Committee (1955-58).

J. H. Drake (AM '47, M '55), of the Southern California Edison Company, has been appointed superintendent of system operation. Mr. Drake has been with the company for nine years. He recently supervised the installation of the company's $200,000 A-C Network Calculator and Transient Computer. Mr. Drake has served on the AIEE System Engineering Committee (1955-58).

Ralph Randall (AM '35), manager, user industries sales, Apparatus Division, Oklahoma City Territory, General Electric Company, retired recently after more than 40 years of service with the company. Mr. Randall has been active in the AIEE as chairman of the Oklahoma City Section. He served on the AIEE Industrial Power Applications Committee (1944-46).

J. H. Fisher (AM '53), head of the Controls and Auxiliaries Section, aeronautical systems department, The Ramo-Wooldridge Corporation, has been appointed manager, special energy programs, Electro-Optical Systems, Inc., Pasadena, Calif.

OBITUARIES

Walter B. Morton (AM '25, M '28, F '42) chief electrical engineer, Pennsylvania Power & Light Company, Allentown, Pa., died recently. Mr. Morton was born in Dallas, Texas, on February 3, 1896. After early experience with the U. S. Navy, Mr. Morton became a designer for the Pacific Gas and Electric Co. In 1925, he joined the Alabama Power Company and in 1931 he became associated with the Philadelphia Electric Co. During World War II, he served as a Commander in the U. S. Navy. In 1945, he joined the Pennsylvania Power & Light Company, where he was named chief electrical engineer in 1957. Mr. Morton was a member of several technical organizations including the Edison Electric Institute, Institute of Radio Engineers, National Society of Professional Engineers, and American Society for Engineering Education. Mr. Morton served as a director of the AIEE, 1941-46, and as vice-president of District No. 2, 1953-55. He was chairman of the Administration Department, 1957-58, and served on the following Institute Committees: Sections (1940-44); Membership (1941-43, 1955-57); Technical Program (1941-43); Transfers (1941-42); Land Transportation (1944-47); Marine Transportation (1945-46); Planning and Co-ordination (1946-47, 1955-56, 1957-58); Executive (1954-55); Public Relations (1955-57); Student Branches (chairman 1955-57); Admission and Advancement Department (1956-57); and Professional Development and Recognition Department (1956-57).

W. B. Morton

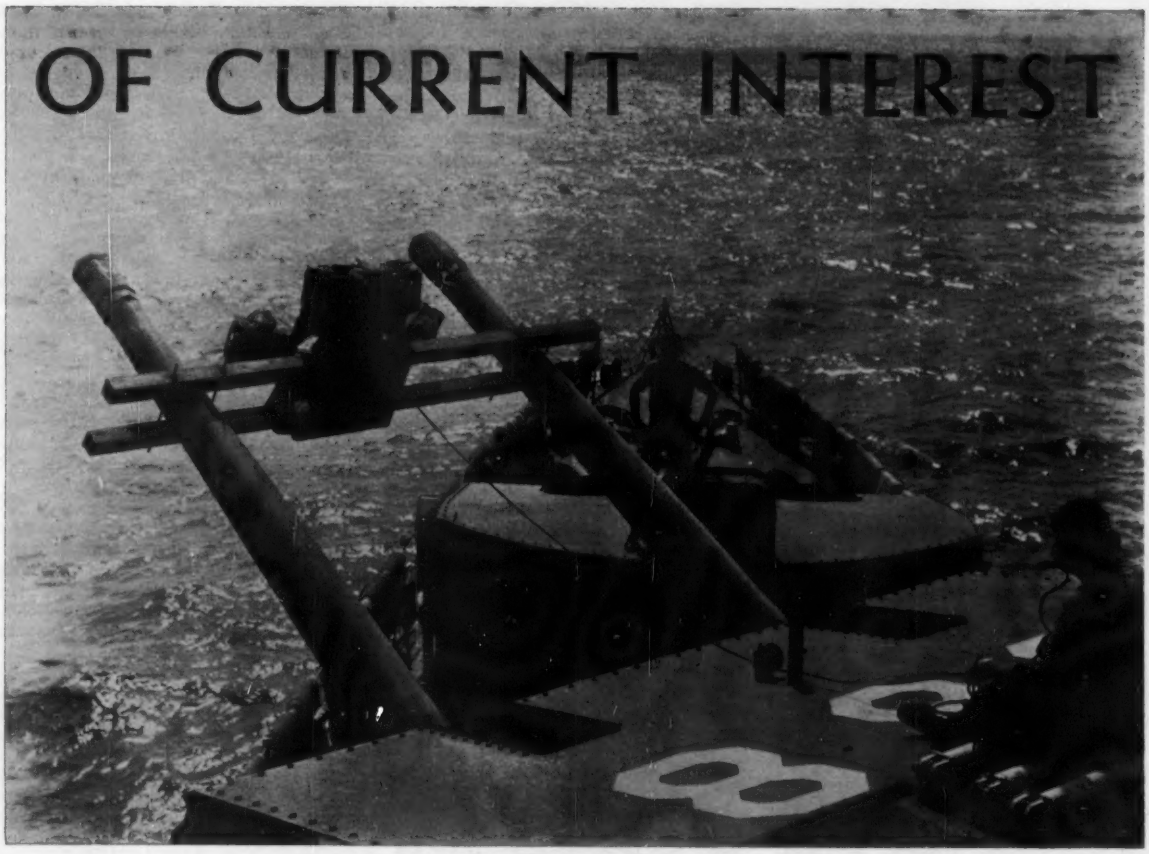
Konstantin K. Paluev (AM '20, M '29, F '48), consulting engineer, power transformer deparment General Electric Company, Pittsfield, Mass. died recently at the age of 64. Mr. Paluev was born in Moscow, Russia, in 1894. He was graduated from the Polytechnic Institute of Peter the Great, Petrograd, Russia, and came to the United States in 1916. He joined the General Electric Company in 1918 on the Test Program transferring in 1919 to Pittsfield. Among his many accomplishments were the development of forced cooling of station transformers, reducing the weight and size of transformers, and development of the nonresonating or shielded transformers to resist lightning. He recevied two Coffin Awards and 22 patents for this work and for his activities in the field of heat transfer. Mr. Paluev served on the AIEE Protective Devices Committee (1933-34) and Research Committee (1936-39).

Arthur Molyneaux Stiles (AM '43, M '51), electrical engineer with the Martin Company, Denver, Colo., died recently. He was 38 years old. Mr. Stiles was born October 3, 1919 in Cherokee Iowa. Following his graduation from Iowa State College, he joined the Westinghouse Electric Corporation in East Pittsburgh, Pa. He went to Denver in 1948 to teach at the University of Denver and work in its research laboratory. In early 1957, he went to work as a senior engineer at the Martin Company Denver plant. Mr. Stiles was the counselor of the Denver University Student Branch for several years and was chairman of the AIEE Denver Section Membership Committee (1956-57).

John C. Buchanan (M '46), electrical engineer, Tennessee Valley Authority, died recently at the age of 55. Mr. Buchanan was born in Knoxville, Tenn., on December 24, 1902. He was graduated from Knoxville High School in 1922 and later studied electrical work with Bliss Electrical School. From 1922 to 1933, Mr. Buchanan was associated in various electrical capacities with several firms including Knoxville Radio Company, Brevard County Power Company, Knoxville Power and Light Company, Warner Service Company, and Tennessee Armature and Electric Company. He was associated with the Tennessee Valley Authority for over 24 years beginning in 1933. Mr. Buchanan had been serving as a director of the AIEE East Tennessee Section.

Ray Leckley Horr (M '26, Member for Life), retired, died recently in Denver, Colo. He was 76 years old. Mr. Horr was born June 27, 1882, in Clinton, Iowa. He was graduated with an electrical engineering degree from the University of Illinois in 1904. Mr. Horr served as general plant supervisor and general plant engineer for the Mountain States Telephone and Telegraph Company. During World War II, he was appointed an assistant vice-president of the company to co-ordinate its activities in the provision of communication facilities for the armed services. He retired from this position in 1947 after 37 years of service with the Bell System.

OF CURRENT INTEREST



▲SPECTRAL METEOR CAMERA, one of the major instruments used in "Operation Gaslight," was built by Barnes Engineering Company. Made up of a cluster of six *F-8* aerial cameras equipped with spectral gratings, the instrument is shown on the 5-inch gun mounts of the *USS Stickell* for stabilization against ship's roll and pitch.

Radiometric Measurements of Jupiter IRBM Made by Tracking

JUPITER IRBM at takeoff from Patrick Air Force Base firing range at Cape Canaveral, Fla. This missile appears to be equipped with a nose cone similar to that which was on the Jupiter that was studied at re-entry by Operation Gaslight.

WIDE-FIELD radiometer Model *R-4K1* is designed for making radiometric measurements of fast-moving targets. It can be used under conditions where mechanical mounting and pointing systems are too slow or too inconvenient for use in acquiring and tracking such targets. The instrument weighs 13 pounds and is constructed to be held and pointed much as a shotgun, for ease of handling and rapid acquisition and tracking of the target. Because of these and additional features the Model *R-4K1* is ideally suited for field measurements of the radiation from high-speed missiles and aircraft.

Special Purpose Design

Model *R-4K1* was specially designed to meet the unusual requirements of "Operation Gaslight," the Jupiter C re-entry measurement program. Its success in that mission demonstrates its usefulness in field radiometric measurements.

A major feature in providing ease of target acquisition and tracking is the unusually wide field of view, which is circular and available in angles as wide as 4 degrees. To make the instrument useful for measuring targets at widely different temperatures, the detector and preamplifier are constructed as an easily interchangeable package. Available for use are lead sulfide, infrared photomultiplier, and germanium immersed thermistor bolometer detectors, packaged with matching preamplifiers.

Day or Night Measurements

The Model *R-4K1* has provisions to optimize its function for day or night measurements. At night, total radiation chopping is used. In daytime measurements space filter chopping is used to suppress uniform background signals by several orders of magnitude.

The wide-field radiometer consists of an optical head and an electronics unit connected by a single cable. The optical head is equipped with a gunstock and pistol grip to provide ease of handling. A telescope sight with illuminated reticle is mounted on the upper surface of the head

to permit easy target acquisition and tracking during day and night. Boresight motion picture cameras are available as an accessory. The head can be removed from its gunstock and mounted, by means of a tripod socket, on a high-speed pedestal, radar antenna, infrared tracker mount, or optical tracker mount, for simultaneous use with other instrumentation.

Inasmuch as interstellar space approaches absolute zero, any object at all will give off energy which can be measured by infrared meters.

What Is Infrared?

Light, X rays, radio, radar, atomic radiation—and infrared—all are examples of what is called electromagnetic radiation. These are forms of energy obeying the same physical laws and displaying many common physical traits.

All objects normally emit infrared radiation. Only at absolute zero (−273 C). when molecular action ceases, does infrared radiation also stop. Normally, the infrared radiation emitted by a body covers a broad band, but there is a peak of radiation emitted at a wavelength determined by the temperature of the object. As the temperature increases, the peak radiation occurs at shorter wavelengths.

Objects at 0 F, for example, have their peak radiation at about 10 microns (a micron is 1/10,000th of a centimeter), at 500 F, this wavelength peak has decreased to 5.5 microns. As the object becomes more and more heated and the wavelengths become shorter, the emitted radiation becomes visible—the object is now "red hot." This takes place at about 1,000 F, with wavelengths about 4 microns long.

The total radiation emitted by any object depends mainly on two factors: its temperature and its emissivity. A simple equation makes this clear:

$$W = ekAT^4$$

where W is the total radiation (in watts), e is the emissivity factor, k is a constant, A is the area in square centimeters of the heated source, and T is the temperature of the source in degrees Kelvin (degrees Centigrade above absolute zero).

It is possible, therefore, to have different objects of the same size at different temperatures emitting the same quantity of infrared radiation. By the same token, different objects at the same temperature may emit different quantities of infrared radiation.

Jupiter Nose Cone

Photographs of the spectacular re-entry into the Earth's atmosphere of the Jupiter IBRM (intermediate-range ballistics missile) which took place May 18 have made scientific and military history. It marked the first successful recovery of a full-scale Jupiter nose cone. This nose cone is capable of containing a nuclear warhead and protecting it from destruction by aerodynamic heating in the atmosphere.

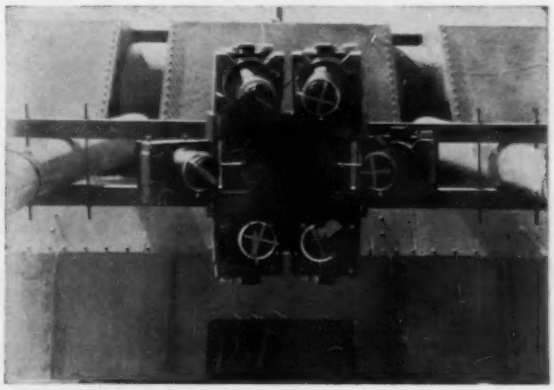
These pictures were taken as part of "Operation Gaslight," the Armed Forces project for investigating the physics associated with the re-entry of the Jupiter missile. This operation was directed by D. D. Woodbridge and R. V. Hembree of the Army Ballistic Missile Agency (ABMA). It included scientists from Barnes Engineering Company of Stamford, Conn., U.S. Air Force Cambridge Research Center, AVCO Research Laboratory, and Aerojet-General Corporation. The missile re-entry was studied by means of photographic, radiometric, and spectrographic techniques and equipment.

The Jupiter IRBM was fired from Cape Canaveral, Fla., at 1:06 a.m., May 18.

Fifteen minutes later and 1,500 miles away, northeast of the island of Antigua, scientists tracked the missile as it re-entered the atmosphere at a speed of 9,000 mph. The distance of the target area from land necessitated the use of ships for the operation. The observers were aboard the *USS Stickell, DDR 888*, a radar destroyer assigned by the Navy. Additional personnel and equipment were aboard the firing range's telemetry ship *MV Swordknot*. The roll and pitch of the ships made it necessary to mount some of the equipment on the stabilized 5-inch guns of the *Stickell*.

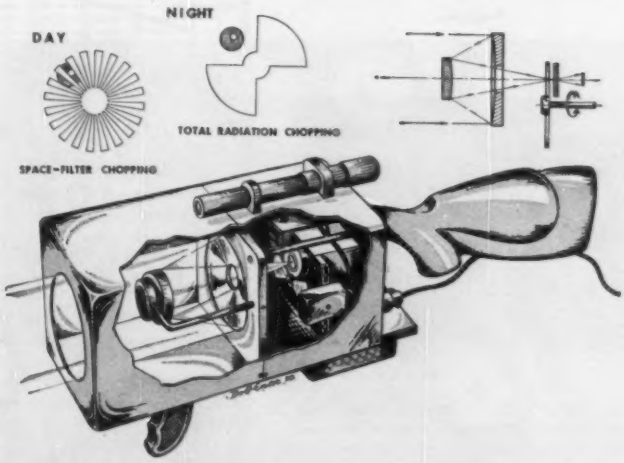
Re-entry Phenomena

The missile was predicted to become visible just off the ship's bow at an elevation of about 45 degrees, directly under the star Arcturus. The flight path would pass directly under the star Spica and the



SIX *F-8* aerial cameras equipped with spectral gratings and arranged in such a way as to afford a panoramic view of a large portion of the sky are shown mounted on the 5-inch guns for stabilization against ships roll and pitch. These Barnes instruments were used in Operation Gaslight.

RADIOMETER used to measure radiation from Jupiter IRBM as it re-entered atmosphere is held by Barnes field engineer aboard *USS Stickell*, a U. S. Navy destroyer assigned to Operation Gaslight. The



ABMA project to study light and heat given off as a missile re-enters the atmosphere was photographed by the Model *R-4K1* developed to measure such phenomena.

missile would disappear nearly off the ship's beam.

Cdr. Brown, captain of the ship, was the first to spot the re-entry phenomenon, which, at first, appeared about as bright as a star of the third magnitude and occurred at approximately the predicted position.

Heated by air friction as it re-entered the atmosphere at enormous speed, the missile glowed so brilliantly that the *Stickell*, more than 50 miles away, was perceptibly illuminated. The total time of visibility was about 24 seconds. The radiation (electromagnetic energy) from all portions of the spectrum of the re-entering Jupiter, including both visible and infrared, was so tremendous, that it saturated some of the instruments. The photographs showed that, within seconds after the first re-entry light was observed, the phenomenon had blossomed into three distinct objects.

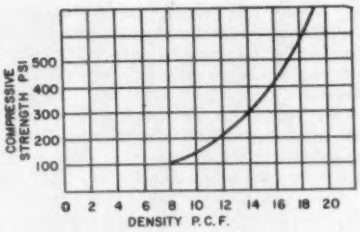
The brightest object, which resembled a huge magnesium flare, was assumed to be the booster (rocket body), or motor package. The light emitted by this object definitely pulsated. At one time, the object's trajectory was nearly in line with the planet Jupiter, and was estimated to be at least 1,000 times brighter.

The second brightest visual object was assumed to be the instrument compartment, which appeared blue-green and then turned white. The trajectory of the instrument compartment during its burning stage was much shorter than the booster and nose cone. During the last few seconds of the visible flight, the booster and nose cone (which glowed orange-red) moved behind a large cumulus cloud to the south of the *Stickell*. The radiation was so intense that the whole cloud was illuminated.

Barnes was selected by ABMA to perform spectral and radiometric measurements on the re-entering bodies of the missile.

Equipment Used

One of the special instruments designed by the Stamford firm for Operation Gaslight was a meteor-type spectral camera, which uses a cluster of six aerial reconnaissance cameras equipped with spectral gratings and arranged to afford a panoramic view of a large portion of the sky. This large instrument was mounted on one of the *Stickell's* 5-inch gun mounts, which is stablilzed by gyroscopic control to reduce the effects of the roll and pitch of the ship. Other instruments used included a number of specially designed radiometers, held by hand. Motion picture cameras recorded the falling bodies.



PHYSICAL properties of Foamsil are depicted in graph.

Pure Silica Foam Is High-Temperature Insulation

SUCCESS in causing pure silica to boil and foam has created an entirely new acid-resistant insulating and refractory material. The material has a wide range of applications in the chemical and chemical process industries as well as many areas of the metallurgical, electrical, electronic, nuclear energy, petroleum, petrochemical, and aeronautical fields.

Properties

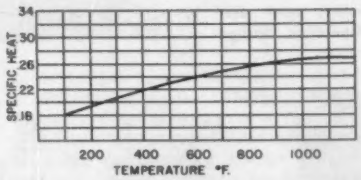
The new material, called Foamsil, is

Courtesy Associated Photographers

OXYACETYLENE TORCH blasting 2-inch thick block of Foamsil throws a flame of over 6,000 F. Insulation properties of the new foamed silica acidproof refractory material developed by Pittsburgh Corning are so effective that company official holds it against cheek during demonstration.

99% pure fused silica and can neither oxidize nor absorb moisture. It is unaffected by all acids, with the exception of hydrofluoric and hot phosphoric.

The material offers continuous insulat-



THERMAL properties of Foamsil are shown in graph.

ing protection and withstands thermal shock within the range of —450 to +2,200 F. The insulating value of one inch of Foamsil is equivalent to that of 18 inches of acid brick at an operating temperature of 250 F.

The temperature range of the new material, according to Russell Brittingham, Pittsburgh Corning Corporation president, is greater than that practical for any other insulating or refractory material currently available to industry in the United States.

Foamsil is now being produced in quantity at the company's Sedalia, Mo., plant in a special continuous horizontal electric furnace. The furnace, said to be the first of its kind, was built to the company's specifications.

The pure silica, activated by a foaming agent, foams into millions of tiny, non-interconnecting bubbles. When cooled, a lightweight, rigid, inorganic block, with a closed cell structure, results.

Stability

The dimensional stability of the material is exceptional. It does not warp,

Courtesy Pittsburgh Corning

FOAMSIL is available in blocks up to 3 inches thick as well as in prefabricated curved segments, wedge shapes, and other formings. It can also be cut to size in the field.

shrink, or slump during rapid temperature changes. When subjected to intense heat (such as that of a steel-cutting oxy-acetylene torch) and then water-quenched, it does not crack or spall.

A low expansion coefficient of 3.5×10^{-7}, about one-eighteenth that of low-carbon steel, gives the material volume stability throughout its entire temperature operating range. For operating temperatures up to 2,200 F, Foamsil actually expands whereas most insulations shrink. It has been heated in a furnace at 1,600 F for more than 2 years without any evidence of deterioration. This feature reduces the need for expansion joints and vertical clearances, and virtually eliminates joint separations caused by expansion and contraction.

Light in weight (10 to 12 pounds per cubic foot) and having a compressive strength of 130 to 210 pounds per square

inch, Foamsil can be used as a load-bearing surface to eliminate some of the supporting and reinforcing structure required with conventional material.

The material is available in block sizes of 11 inches by 17 inches, 17 inches by 22 inches, in thicknesses up to 3 inches. Greater thicknesses may be obtained by laminating. Approximate cost of the material is 50¢ per board foot.

Applications

Laboratory and industrial applications show Foamsil to be ideal as a lining inside tanks and pipe lines that contain hot acids of any concentrations. The sealed silica cells prevent absorption of the acids, inflammable solvents or vapors, thus assuring full original insulating value throughout the life of the equipment it serves. Because of the absence of capillary action, Foamsil also cannot act as a wick for transfer of inflammable liquid or gas to critical areas.

Concrete, brick, or steel stacks subjected to corrosive atmospheres may be readily lined with the lightweight acid-resistant material. It can likewise be used as underground thermal and electrical insulation.

In addition, its dielectric constant of 1.155 and loss tangent of 0.003 (9.4 pound per cubic foot density at 9,400 mc per second and 26 C) promises value in the high-temperature electrical insulation field.

Mackinac Bridge Has a Maintained Illumination of 1.0 Footcandle for Night Safety

SKEPTICS said that this was the bridge that couldn't be built. It was, and is, one of the costliest and longest of suspension bridges.

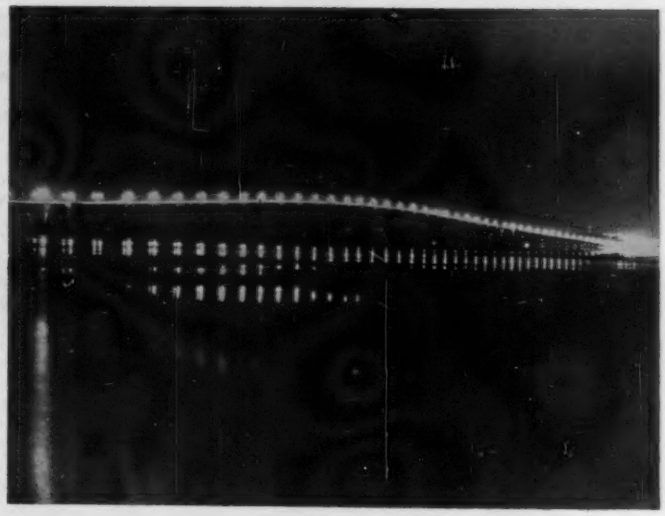
Postmaster General A. E. Summerfield, principal speaker at the dedication ceremonies predicted that ". . . it may very well be that future historians will include the Mackinac Bridge in the proud category of Mankind's outstanding accomplishments when the story of our 20th Century is finally written, as it will be in part, in terms of our great public works."

The gleaming bridge has been lighted with mercury luminaires to provide safe passage for the thousands of nighttime motorists who travel between the upper and lower peninsulas of the State of Michigan. It replaces a state-operated ferry system which formerly provided the only link between Michigan's industrial southern area with the scenic northern promontory.

Although the center span of 3,800 feet is 400 feet shorter than that of San Francisco's Golden Gate Bridge, Mackinac Bridge measures 8,614 feet between anchorages compared with 6,450 feet for the Golden Gate.

Visitors to the Mackinac Straits area were provided the opportunity to obtain commemorative stamps issued for the opening day ceremonies and later. They were also able to get souvenir envelopes with stamps affixed and cancelled with a special cancellation authorized for use on June 25, 1958, only. The unique cancellation reads, "Mackinac Bridge, Michigan," and was used both at the St. Ignace and Mackinaw City Post Offices by special permission.

As far back as 1884, William Saulson and



ARCHWAY on Mackinac Bridge (above) frames brightly lighted thoroughfare stretching beyond to speed nighttime motorists safely between Michigan's northern and southern peninsulas. Uniform level of illumination (*top, right*) is maintained on bridge by General Electric Company 400-watt (21,000 lumens) mercury luminaires. Night view of the span (*bottom, right*) shows reflection of lights from bridge in the waters of the straits.

others were dreaming of bridging the famed Mackinac Straits. Studies toward that end were made in 1920, 1935, and 1940. Following World War II, studies were made again in 1950, and in 1953 authorization to start was unanimously approved.

Travelers in the Wolverine State will find that the 257 mercury luminaires manufactured by General Electric Company which are used to illuminate the bridge at night are extremely well-suited and provide an even carpet of light across the span. The 400-watt (21,000 lumens) mercury luminaires are designed to distribute light longitudinally along the pavement. Units are mounted at staggered intervals of 155 feet and at heights of 30 feet on tapered aluminum poles with 8-foot brackets. Average maintained illumination on the bridge is approximately 1.0 footcandle.

At the toll plaza, luminaires are located directly opposite each other along the east and west boundaries at intervals of 90 feet. For this application, the 400-watt (23,000 lumens) units were used to provide the desired transverse light distribution, thus maintaining illumination in this area to 1.3 footcandles.

The equation for determining the average maintained footcandle level is as follows: lamp lumens $\times$ utilization factor $\times$ maintenance factor/roadway width $\times$ luminaire spacing $=$ average maintained footcandle.

The lighting system operates from eleven 6.6-ampere series circuits. Power output for the bridge is split between the Edison Sault Electric Company which supplies 590 kw at the northern end of the span, and the Consumers Power Company which provides 180 kw at the southern terminal. Both companies supply 3-phase, 4-wire, 2,400/4,160-volt power. At each of the bridge's six substations, 3-phase, 4-wire, 120/208 Y power is provided for low-voltage circuits by step-down distribution transformers.

In addition to the main lighting equipment, GE supplied three single-phase, 100-kva distribution transformers, six single-phase, 25-kva distribution transformers; one single-phase, 15-kva distribution transformers; six single-phase, 5-kva distribution transformers; eleven 25-kw constant current regulators; and associated control equipment including circuit breakers and control panels for the power distribution system of the bridge.

The bridge was designed for the greatest possible safety, and is said to be the safest bridge in the world aerodynamically. Bridge users will save time as well as money, eliminating the often irritating wait (sometimes as long as 19 hours) for the ferry to cross the straits.

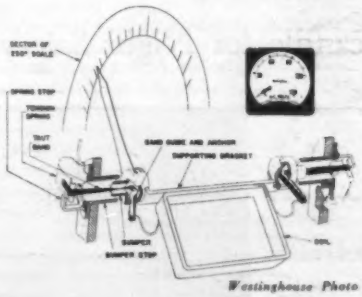
Switchboard Instruments Use Taut Band Suspension System

For its new *KX-241* line of circular scale switchboard instruments, the Westinghouse Electric Corporation Meter Division has developed a unique taut band suspension system that uses no pivots or bearings and is completely free of rolling or sliding friction. The only frictional loss is an infinitesimal amount of molecular friction within the taut metal bands.

This new development makes it possible to build electrical measuring instruments that can withstand severe vibration and shock without any effect on their accuracy.

The taut band suspension principle has been previously applied only to galvanometers of the laboratory type, a limited number of high-cost American instruments, and some 90-degree instruments built in Europe. The new instrument line, is was stater, is the first application in the United States of taut band suspension to instruments for general industrial service, and the first application in the world to 250-degree instruments.

In instruments with taut band suspension, the moving element is supported at each end by a short hair-like band of a special high-strength alloy drawn to rectangular cross section. Measuring 5×10^{-3} inch wide and 5×10^{-4} inch thick, the bands are dimensionally controlled to less than 5×10^{-6} of an inch.



Westinghouse Photo

ESSENTIALS of instrument line construction in which hair-like metal bands under tension support the moving element, carry current to the coil, and supply restoring torque. New 250-degree d-c switchboard instruments using this construction are proof against severe vibration and shock. No pivots or bearings are required and rolling and sliding friction are eliminated.

The bands are permanently anchored to the moving element of an instrument and to U-shaped springs which maintain proper band tension and contribute to immunity to shock and vibration. Small stops prevent excessive axial and radial movement as a further measure for shock-proofing. In addition to serving as the "axle" for an instrument, the taut bands also carry current to the moving coil and, by providing restoring torque, eliminate the need for spiral springs. In instruments built with taut band construction, sensitivity of an unusual degree is inherent. Full-scale 250-degree deflection can be obtained with currents as low as 50 microamperes.

Decision to apply taut band suspension first to the *KX-241* line of circular scale d-c switchboard instruments was made by Westinghouse in recognition of the wide applicability of this family of instruments throughout industry, particularly in the electric utility industry and in heavy industry where many shock and vibration problems cause serious delays in the manufacturing process.

Instruments making up the *KX-241* line comprise d-c ammeters, milliammeters, and microammeters, and voltmeters and millivoltmeters. Frequency meters with transducers and a-c voltmeters of the rectifier type are also included.

Instruments in the line meet or exceed requirements of ASA Specification C39.1 for indicating instruments. In addition to taut band suspension, the instruments also have a new magnetic circuit that makes them practically impervious to stray magnetic fields. Specifically, when subjected to a 300-gauss field instrument indication will be affected by no more than one per cent.

Heat Transfer Conference at Chicago, August 18-20, 1958

Some 30 technical papers and a manufacturers' exhibit were features of the Second Annual Heat Transfer Conference at the Edgewater Beach Hotel, Chicago, Ill., August 18-20. The Conference was sponsored by the American Institute of Chemical Engineers (AIChE) and the American Society of Mechanical Engineers (ASME).

The exhibit, in which a score of manufacturers participated, showed the latest in heat transfer equipment, media, and ancillaries.

The technical program, of which A. S. Foust, AIChE, and S. Kopp, ASME, were in charge, was a comprehensive one with national authorities on heat transfer presenting advances in the field. ASME has been active in the heat transfer field for many years. AIChE has held numerous symposiums and meetings on the subject and recently organized a Heat Transfer Division.

Portable Radio Plays on Free Power from Sun

The world's first solar-powered portable radio priced competitively with comparable conventionally powered models was introduced recently by the Consumer Products Division, Hoffman Electronics Corporation.

The new personal-sized portable, called the Trans-Solar, uses Hoffman-made silicon solar cells which convert light energy into electricity. The cells are encased in a built-in solar battery pack in the top of the set and may receive their energy from either sunlight or from a standard 100-watt incandescent bulb.

These solar cells, tiny wafers of highly purified and specially treated silicon, are actually energy converters with unlimited life. Manufactured by Hoffman's Semiconductor Division, Evanston, Ill., the cells are the same type as those used to supply power for the radio transmitter in the Navy's Vanguard satellite.

The Trans-Solar radio features six transistors plus one diode, printed circuit wiring, push-pull output, a 2½-inch

speaker, and provision for earphone operation. A long-life, four-volt mercury battery, provided for operation when no light is available, is readily accessible for replacement without disassembling the case.

Measuring only 5¾ by 3½ by 1⅝ inches over-all, the Trans-Solar radio is designed to fit easily into pocket or purse. It also features an unbreakable Cycolac case for extra durability.

Wrap-Around Antenna Developed

A television broadcast antenna test site was unveiled recently with the announcement of a new low-channel vhf (very-high-frequency) helical antenna that wraps around antenna-supporting towers rather than being constructed on a separate mast atop the tower. A project of the General Electric Company's Technical Products Department, the test site, located atop a 1,350-foot hill at Cazenovia, N. Y., is said to be the only such commercial site approaching "free space," or having completely unobstructed test facilities. Thus, more precise measurements of high-gain antenna patterns may be obtained with this new equipment.

H. G. Towlson, manager of engineering for the company's Technical Products Department at Syracuse, N.Y., described design of the new antenna as revolutionary. It is designed for use on channels 2 through 6. High channels are defined as channels 7 through 13. The new television broadcast antenna, known as a vhf wrap-around helical antenna, consists merely of a heavy copper-clad steel rod, or helix, coiled around a section of the steel antenna tower. The helix is the antenna itself. Inasmuch as no separate mast is required, the original costs for erecting antennas are expected to be cut sharply.

Comparable batwing antennas now used by vhf television stations comprise a 100-foot long 18,000-pound mast on which are constructed many radiators shaped like batwings. High-channel vhf helical antennas consist of a 53-foot long, 5,500-pound mast entwined in a heavy copper-clad steel rod. The rod, or helix, is three eights of an inch in diameter. Batwing and helical antennas need to be hoisted and mounted atop towers ranging in height from 200 to 1,500 feet, depending on location.

Principal advantage of the new wrap-around helical antenna is its simplified design. It requires but one feed point, as against 16 feed points needed for a comparable batwing. Feed points—locations on the antenna mast where visual and aural signals are fed into the antenna radiators—are the most common source of trouble. With but one feed point required for the new antenna, maintenance needs will be sharply reduced.

Developed and designed by a team of engineers, headed by L. O. Krause and R. E. Fisk, the test-site antenna is a prototype of one expected to be engineered for a new television station to be built in the near future.

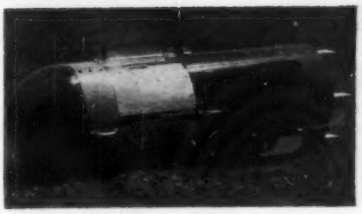
"Grasshopper" Transmits Weather Automatically

At a recent electronics conference in Washington, D.C., the U. S. Navy's Grasshopper, the Automatic Weather Transmitter *AN/GMT-1 (XG-1)*, was introduced. Designed, developed, and built by the U. S. Naval Avionics Facility, Indianapolis, Ind., the Grasshopper was shown and demonstrated by the Cleveland Metal Specialties Company, which designed and manufactured the printed circuits used in the unit. The Grasshopper is completely automatic from the time of drop from the aircraft.

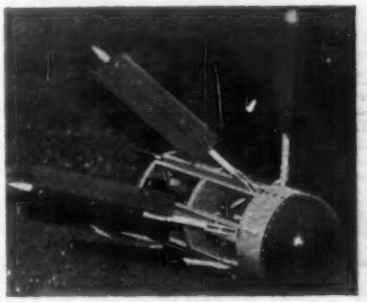
The operation of the station, after drop and automatic set-up, is governed by a program timing clock. At predetermined intervals the clock contacts start the transmission sequence. When the contacts close, all tube filaments have power applied to them, and they are allowed to heat for 30 seconds, after which operating voltages are applied to the entire equipment, and transmission begins. At the beginning of transmission, the station identifies itself by sending its call letters. As the letters are completed, each weather transducer in turn is switched into a circuit to operate a servo system which selects the code letters, corresponding to the weather information, to be transmitted. Each of the code letters is transmitted several times before the next set of data is transmitted so as to insure adequate reception. At the completion of the transmission, a cam-operated switch returns the system to its normal nonoperating condition, and the unit remains in that condition until the program timer initiates the next transmission.

The wind direction transducer, a weathervane that streamlines itself by heading into the wind, is connected to a mounted shaft through the pedestal or base of the anemometer assembly. This transducer uses the physical structure of the weather station rather than the earth as its directional reference. It is necessary, therefore, to know the direction in which the weather station is oriented in order to determine the wind direction from the transmitted code letters. To do this, a red arrow or pointer, clearly visible from the air, is painted on the legs of the station. The crew of the drop aircraft, using their own instruments, determine the bearing of the arrow.

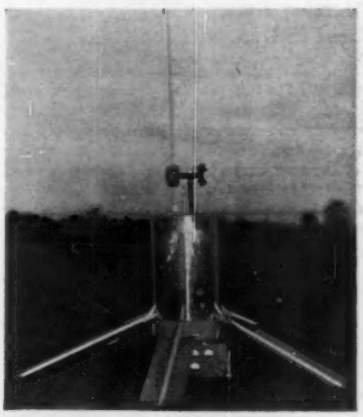
The wind direction information transmitted by the station is on the basis of the heading of the arrow equal to 0 degrees. Thus, by knowing the bearing of the weather station and the direction of the wind in relation to the weather station, it is possible to calculate the bearing of the wind. The wind measuring method uses a propeller (or impeller) driven 4-pole magnet and spring-loaded aluminum drag cup. The latter is placed in the magnetic field of the permanent magnet. When the magnet rotates because of the action of the wind on the impeller, a rotational force is imparted to the drag cup that is proportional to the speed of rotation of the magnet. A linear spring is anchored to the drag cup by the rotating magnet. A potentiometer is connected to the drag



GRASSHOPPER, U. S. Navy's automatic weather transmitter, shown before drop. At time of drop, static cord releases tie-down cables enabling tail cone to be ejected, allowing parachute to be deployed, and simultaneously pulling pin which starts erection-delay timer. When unit hits ground, locking pin of parachute ground release mechanism falls free because of removal of weather station's weight, and parachute is disengaged automatically.



AFTER LANDING, station remains horizontal until erection-delay timer closes contact to fuse wire holding spring loaded self-righting hammer valve. Gas pressure actuates post release, leg release, and leg jacks, forcing station to erect itself perpendicular to ground.



Official Photographs, U. S. Navy

POSITIVE SUPPORT is provided by legs, which mechanically lock themselves in position. About 15 seconds after station is upright, wire holding spring-loaded antenna hammer valve fuses, releasing the remaining gas pressure to erect telescopic antenna.

cup shaft by means of a flexible coupling. The potentiometer is linear, 0 to 2,000 ohms. By properly adjusting the strength of the magnetic field and the strength of the retaining spring, the anemometer may be calibrated to read wind speeds from 0 to 80 knots.

The temperature transducer consists of a 360 degree minitorque potentiometer actuated by a loosely wound spiral core of bimetal which is wound so that it opens with the lowering of the temperature and can turn the potentiometer as much as 720 degrees over the temperature range of —70 to —140 F. The instrument should vary between 0 ohms and 2,000 ohms from —70 to about —30 F. Then it drops back to 0 ohms with further increases in temperature. As the temperature continues to rise, the resistance will continue to increase until it again reaches approximately 2,000 ohms at —140 F. A fine mesh screen is used to protect the coil from handling and from larger pieces of dirt which may get jammed between the coils.

The following table represents a complete transmission sequence:

Order of Transmission	Code Group Sent	Times Repeated
1	Call letters	4
2	Wind direction	3
3	Wind velocity	3
6	Atmospheric pressure	3
4	Temperature	3
5	Atmospheric pressure (high range)	3
6	Atmospheric pressure (low range)	3
7	Call letters	5
8	Wind direction	3
9	Wind velocity	3
10	Temperature	3
11	Atmospheric pressure (high range)	3
12	Atmospheric presssure (low range)	3
13	Call letters	1

Mercury Batteries Used in U. S. Satellites

Small "power plants," consisting of two mercury battery packs, each weighing slightly over 2 pounds, have been used in transmitting signals from outer space. These mercury batteries, developed by P. R. Mallory & Co., Inc., Indianapolis, Ind., have been employed in U.S. satellites Explorer I, II, and III, as well as Vanguard I and II.

Solar cells, which convert power from the sun, were included in Explorer II and Vanguard I. These cells provide power only when ample sunlight strikes the satellite to operate the transmitters. The mercury cells stand by to provide uninterrupted transmission of information on temperature, cosmic ray activity, and atmospheric density. The mercury battery consists of a depolarizing mercuric oxide cathode, an anode of pure amalgamated zinc, and a concentrated aqueous electrolyte of potassium hydroxide saturated with zincate.

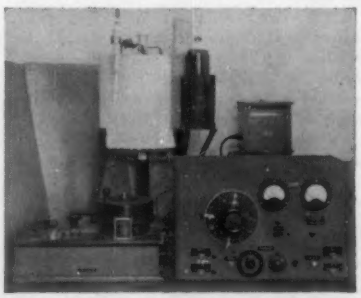
Among the advantages the mercury batteries have over other dry cells is their greater energy in relation to volume and weight. A mercury battery yields from four to six times as much energy as a "conventional" zinc-carbon-manganese battery of the same size. Conversely, the same energy can be provided in a fraction of the space. Depending on the type of equipment in which it is used, the mercury battery has a life several times that of a conventional battery and provides energy at a uniform rate for its entire life. Sealed in steel cases, mercury batteries can withstand severe shock and acceleration.

The mercury battery has had a variety of military, industrial, and consumer applications since its invention 16 years ago. Aside from its use in the famous "Walkie-Talkie" of World War II, the mercury battery is being used in transistor hearing aids, photoflash guns, meters, electric clocks, voltage recorders, radiation detection meters, telephonic transistor equipment, emergency alarm devices, signal lights and flashers, portable paging systems, and regulated power supplies. Among the applications now common to military operations are air–sea rescue transmitters, meterological balloons and oceanographic instruments, guided missile controls, portable field communication equipment, direction finders, weather observation equipment, and a variety of signalling devices.

Controller for Phase-Equilibrium Studies

Phase-equilibrium studies of any chemical system are concerned with the effect of the variation of environmental conditions (temperature, pressure, and composition) on the stability and chemical composition of co-existing phases (gas, liquid, or solid) of the system. Data on phase equilibrium are of vital importance for knowledge of the stability of high-temperature materials, formation of glasses, cements, metallurgical slags, and various alloys. Through use of heterogeneous equilibrium phase diagrams, experimental data on such combinations can be correlated systematically and extended to predict behavior for compositions and experimental conditions not yet explored.

In phase-equilibrium studies at U.S. National Bureau of Standards, Washington, D.C., increasing emphasis is now being placed on the basic properties of high-temperature ceramics and alloys. The phase compositions are identified experimentally by such physicochemical methods as polarizing microscopy, X-ray diffraction, electron microscopy, and infrared spectroscopy, as well as by chemical techniques. The resulting phase diagrams are used to predict, for a given set of experimental conditions, the actual phases present, the compositions of the phases, and their relative concentrations under a given set of equilibrium conditions. Other data that can be obtained in this way include the temperature of initial and final melting of the compositions, components formed, information on solid solutions, extent of liquid immiscibility, and reactions occurring within the system. Such information is essential to the development of new high-temperature materials and in understanding their behavior during firing.



SELF-ADJUSTING CONTROLLER at U.S. National Bureau of Standards maintains precise temperature control of a quenching furnace in high-temperature phase-equilibrium studies.

In high-temperature phase studies, it is important to maintain a sample at a desired temperature until equilibrium is reached. For this purpose, an improved, self-adjusting bridge-type controller that is suitable for precise temperature control of a quenching furnace has been developed. With this controller, a given temperature can be held constant to within 0.3 C. Since the platinum-rhodium winding serves both as a heater and as a sensing element, there is virtually no time delay between a change in power input and a change in temperature.

Based on the Wheatstone bridge principle, the instrument produces a resistance change for every variation in temperature. The deviation which results causes the controller to readjust the power input by means of a variable autotransformer. Thus, the power to the furnace is continuously adjusted to maintain the desired resistance. The apparatus is made of commercial components, and is simple to operate on readily available a-c current.

This and That from Here and There

Communication Via the Moon. Research conducted at the University of Michigan Engineering Research Institute (ERI), Ann Arbor, Mich., indicates that very short-wave radio or radar signals, which can be used in voice transmission, bounce off the moon without appreciable loss in quality. This means that, although a radar signal must travel in a straight line, the earth's curvature need not limit communication distance as long as both transmitting and receiving equipment can "see" the moon. It has been known for several years that it is possible to use the moon as a reflector for long-wavelength signals. ERI research, however, conducted under contract with the Rome Air Development Center of the U.S. Air Force, showed that very short wavelengths of about an inch give an improvement in clarity such that it is now commercially feasible to set up a world-wide network of stations using lunar reflection.

Careful analysis and measurement of radar signals reflected from the moon indicates that its surface is composed of a

sand-like material. The assumption had been that, because of the jagged mountains and craters which are known to exist on the moon, it would appear rough to a radar signal. But the moon has areas which are smooth and, as a result, short-wave signals, which require only an area of a few square feet to be reflected, can bounce off the moon without a loss in quality.

International Atomic Energy Agency. Over 200 fellowships with a monetary value of more than $1 million are now available to the International Atomic Energy Agency (IAEA), which will award them to young scientists and technicians for advanced training abroad, Director-General Sterling Cole announced in Geneva, Switzerland.

The fellowships are financed either through the IAEA's general fund, for which $250,000 was voted by the first General Conference as voluntary contributions, or directly by member governments that have offered facilities to the Agency.

The initial program has been focused on training and exchange of scientists and experts in the field of the peaceful uses of atomic energy.

Fellowships are intended for general technical training to develop skills in some fundamental techniques applied in nuclear energy, specialist training in theoretical and experimental aspects of nuclear energy science and technology, and research training. More than $60,000 is available for fellowships to be awarded under the IAEA's general fund. Offers representing a considerably larger contribution have been communicated to Director-General Sterling Cole by a number of member governments.

In another area of IAEA's program, 11 countries in Latin America were on the itinerary of the first mission sent out for the purpose of aiding less developed nations to benefit from the peaceful uses of atomic energy.

Dr. Norman Hilberry, director of the Argonne National Laboratory, located near Chicago, Ill., was designated head of the team of experts.

The team, which included specialists from the atomic energy commissions of the United Kingdom and France and other experts, visited Brazil, Paraguay, Uruguay, Argentina, Chile, Bolivia, Peru, Colombia, Guatemala, Mexico, and Haiti.

The survey lasted about 5 weeks, after which the team returned to IAEA Headquarters in Vienna, Austria, to write its report.

Dr. Hilberry stated that the mission's task, as he saw it, was to determine what role could be played by the peaceful uses of atomic energy in the economy of Latin American countries; what would be required in terms of manpower in this development; and what could be done, particularly, in developing training centers within Latin America to promote specialized training in nuclear technology.

International Conversations. An exchange of radio programs between American stations and stations around the world has been made possible by a recent $200,000 Ford Foundation grant to the Broadcasting Foundation of America (BFA). In announcing the grant, Robert Redfield, chairman of the Board of BFA, stated, "This exchange of the creative productions of many cultures will be a kind of international conversation, free of politics and propaganda. It will provide an aid to the ear of America, a great widening of the range of things heard and appreciated that originate in unfamiliar lands. In turn, it will bring to audiences overseas the best in American music and writing and thought, reflecting the tradition and culture of the American people." The Broadcasting Foundation, a nonprofit, educational organization, has already made arrangements with radio outlets in 30 countries to have programs on music, literature, and art prepared in English for American audiences, which will be broadcast as a public service by 77 radio stations in the largest cities of the United States. Distribution of foreign programs in this country is expected to begin in the near future.

Radioisotope Uses. Someday engineers will have a handbook for industrial uses of radioisotopes, but not before much basic research is logged in laboratories and many applications are demonstrated successfully in manufacturing plants. This is the opinion of F. L. Green of General Motors' Research Staff's Physics & Instrumentation Department, in an article prepared for the General Motors *Engineering Journal* in which he warns against overselling isotopes as miraculous production or processing tools. Industry's nuclear progress is necessarily slow, he says, because techniques are still crude, supplies of a variety of isotopes are not abundant, and nuclear data are still new and comparatively unreliable. He advocates a boost in the number of conventional engineers with some nuclear knowledge because this would leave such specialists as nuclear engineers and nuclear scientists free to concentrate on basic scientific work in the atomic field.

Solar Heating. A solar heating system of the type which can now be used in American homes in some two thirds of the nation will pay for itself in less than 10 years. One of the world's top solar scientists, J. I. Yellott, said the basis for this estimate is the Solar House, officially opened to the public near Phoenix, Ariz., recently. The system as installed in this house cost approximately $4,000 more to install than a conventional heating and cooling system would have cost in the same house. But the utility bills for heating and cooling will be reduced $550 annually, it was stated. It is estimated that heating and cooling the house through conventional methods would cost $1,000 a year, whereas with the solar system the cost will be only $450 annually including maintenance. All mechanical equipment used in the Solar House is now available commercially and is economically feasible for new construction in all but the eastern third of the nation.

Construction of the Solar House was a project of the Association for Applied Solar Energy, Phoenix, Ariz., an international nonprofit scientific organization.

A low-cost model Solar House was unveiled also in Morocco at the Casablanca Trade Fair in April as a part of the U. S. Department of Commerce Exhibit. Its heating system is said to offer great promise for the underprivileged areas of the

Future Meetings of Other Societies

31st X-ray Diffraction School, Norelco, Sept 8-12, Sir Francis Drake Hotel, San Francisco, Calif. V. W. Palen, Philips Electronics, Inc, Instruments Div, 750 S Fulton Ave., Mt. Vernon, N. Y.

SPE, Regional Technical Conference, Sept 12-13, St. Clair River Inn & Country Club, St. Clair, Mich. T. A. Bissell, SPE, 65 Prospect St, Stamford, Conn.

Instrument Society of America

13th Annual Instrument–Automation Conference & Exhibit, Sept 15-19, (Maintenance Clinic, Sept 14-15), Philadelphia, Pa. F. J. Tabery, 3443 S Hill St, Los Angeles 7, Calif.

Educators Workshop, Sept 17, 9 a.m. to 12 noon, Philadelphia Convention Hall, Philadelphia, Pa. L. E. Slater, FIER, 527 Lexington Ave, New York 17, N. Y.

AIME, Rocky Mountain Minerals Conference, Sept 17-19, Newhouse Hotel, Salt Lake City, Utah. H. N. Appleton, AIME, 29 W 39 St, New York 18, N.Y.

AIChE, meeting, Sept 21-24, Hotel Utah, Salt Lake City, Utah. F. J. Van Antwerpen, AIChE, 25 W 45 St, New York 36, N.Y.

SFSA, 56th Fall Meeting, Sept 22-23, The Homestead, Hot Springs, Va. G. K. Dreher, SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

The Institute of Radio Engineers

National Symposium on Telemetering, Sept 22-24, Americana Hotel, Miami Beach, Fla. Jack Spargo, W. C. Copp Assoc, 72 W 45 St, New York, N. Y.

4th National Aeronautical-Communications Symposium, Communications Systems, Oct 20-21, Hotel Utica, Utica, N. Y. (classified symposium, auspices Directorate of Communications, Rome Air Development Center, Oct 22, Griffis Air Force Base, Rome, N. Y. Clearance required) R. C. Benoit, 138 Riverview Pky, Rome, N. Y.

SES, 7th Annual Meeting, Sept 22-24, Benjamin Franklin Hotel, Philadelphia, Pa. F. F. Van Atta, SES, 1916 Race St. Philadelphia 3, Pa.

The Electrochemical Society, Inc. 114th Meeting, Sept 28-Oct 2, Chateau Laurier, Ottawa, Ont, Canada. R. A. Campbell, The Electrochemical Society, Inc, 552 Booth St, Ottawa, Ont, Canada.

AES, 10th Annual Convention, Sept 29-Oct 3, Hotel New Yorker, New York, N. Y. Sumner Hall, Amityville, L. I., N. Y.

EIA, Conference on Reliable Electrical Connections, Dec 2-4, Dallas, Texas. R. G. Roesch, 1068 S Clinton St. Syracuse 4, N. Y.

Overseas

2nd International Conference for Analog Computations, Sept 1-7, Strasbourg, France.

2nd International Conference on Peaceful Uses of Atomic Energy, Sept 1-13, Geneva, Switzerland. U.N.O.

2nd International Congress on Cybernetics, Sept 3-10, Namur, Belgium. Secretariat, International Association for Cybernetics, 13, rue Basse-Marcelle, Namur, Belgium.

ICAS, 1st International Congress of the Aeronautical Sciences, Sept 8-13, Madrid, Spain. Institute of the Aeronautical Sciences, 2 E 64 St, New York 21, N. Y.

Société des Radioélectriciens, International Symposium on Nuclear Electronics, Sept 16-29, UNESCO House, Paris, France. Colloque International "Électronique Nucléaire," 10, ave Pierre-Larousse, Malakoff, Seine, France.

world. The use of solar energy is important not only to reduce heating bills but also because fossil fuels—gas, coal, and oil—already are approaching exhaustion in areas such as England and are scarce in most sunny nations of the world such as Greece and Turkey.

In addition to storing the sun's energy for heating, the solar collectors are utilized as shade-producing louvers. Integrating the swimming pool with the air conditioning circuit allows the heat pump to operate with maximum economy in both winter and summer. Solar energy is gathered by means of a series of collector panels which are turned to face the sun each day. At night and during the summer, they are rotated so that their aluminum-clad backs face the sky. Water circulated through copper tubes in the collectors is heated and stored in an underground tank, providing a reserve of heat for use at night and during cloudy weather. This heat is transferred into the house as needed by coils mounted on the intake faces of two standard air-to-air heat pumps.

U. S. Branch of German Society. The Society of German Engineers (VDI) announced the registration of an American Branch, in conformity with Act 327, Public Acts of 1931, of the State of Michigan. The American organization was formed for the "establishment of connections, working cooperation, and exchange of experiences in the engineering field among engineering societies, technical institutions, and industrial enterprises in the U. S. A. and Germany."

One of the world's oldest and largest engineering societies, the VDI (Verein Deutscher Ingenieure) was founded in 1856 and now numbers more than 34,000 members in West Germany.

Any engineer whose qualifications are in agreement with the VDI bylaws and who is not restricted by any requirements in this country will be eligible to join this new organization. Further information may be obtained from H. B. Kulose, president of the American Branch, 4850 Balfour Rd., Detroit 24, Mich.

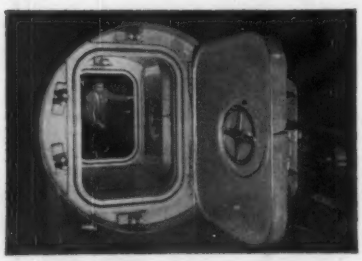
Air Locks in Nuclear Domes

The reactor containment vessel, a dome-like structure which surrounds nuclear reactors and their accessories, is a precautionary feature to insure that a reactor incident, should it occur, will not contaminate the atmosphere with radioactive material. The volume of the reactor containment vessel is so chosen that any nuclear explosion will produce only a very small increase in internal pressure, and the explosion will be "contained" within the vessel itself. The "doors" to this containment vessel must be specially constructed air locks.

The air locks built by Henry Pratt Company, Chicago, Ill., one of the major suppliers of air locks for the nuclear power industry, are made in a variety of sizes, from three-by-six foot openings to admit only personnel, to locks large enough to permit passage of trucks.

A complete air lock consists of two doors and a connecting tunnel. The doors are interlocked so that only one may be opened at a time, and personnel using the lock must close themselves into it as an intermediate step in passage into or out of the containment vessel.

Air locks have been made for both manual and fully automatic operation. Automatically operated locks utilize as a door seal an inflatable rubber tube clamped to the periphery of the door. When the door closes, the seal inflates against a polished stainless steel door frame, completely sealing the containment vessel in which it is installed. For higher pressures, a compression type door seal is used. With this type of seal, a stainless steel lip on the door is squeezed into a rubber ring mounted on the door frame. Compression door seals can withstand any practicable pressure without leakage.



PERSONNEL AIR LOCK for GE Atomic Power Reactor, Pleasanton, Calif. Henry Pratt Company engineer stands at exterior door of lock.

NEMA Elects New 1958 President

J. L. Singleton, vice-president, industries group, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., was elected president of the National Electrical Manufacturers Association (NEMA) recently to fill the unexpired term of the late W. V. O'Brien.

Mr. Singleton has been a member of the NEMA Board since 1952, and served as vice-president since 1955. The NEMA will elect its 1959 officers at the annual convention in November 1958 at Atlantic City, N.J.

Fountain of Lights On in Rockefeller Center

The new Prometheus Fountain of Lights in the lower plaza at Rockefeller Center were turned on for the first time at the opening of the Promenade Cafe late in the Spring. The first fountain installation of its kind in New York City, the color fantasy in water and light was a spectacular highlight of summer in the heart of midtown Manhattan. Some 50 new water jets were installed behind the famous Prometheus statue to form a backdrop curtain of water 14 feet high upon which constantly changing colors play. Underwater lighting in the two levels of the fountain also floods the jets, waterfalls, and pools in brilliant color patterns.

The new lighting combines the theater arts with the science of electronic automation. Controlled by an electronic system, a regular 12-minute performance is given at set intervals every evening from dusk to 1:00 a.m. Each show is composed of 24 different color combinations in 10 grades of brightness which blend and contrast every 10 seconds. Underwater 4-color lights, aimed to give a higher intensity of light on the upper part of the back wall jets, produce a 3-dimensional look. Additional underwater lights bathe the waterfall in soft tints while others infuse color into the shafts of the water sprays. The changing color patterns against the water backdrop and on the cascading waters in the pool produce a feeling of motion throughout the huge fountain. The colors blend into new patterns of light so smoothly and gradually that a complete change in lighting is effected before spectators are aware of the transition. Each show is climaxed by a burst of white light and is followed by an intermission of several minutes.

The lighting is controlled from a switchboard in the sub-basement below the fountain. The cueing of changes is automatically operated by an intricate control panel consisting of 9 dimmers with 20 different dials on each dimmer, producing 180 pre-sets and 20 different scenes. As in lighting a theatrical production, the switchboard is locked in position to regulate the timing. More than 6,000 gallons of water per minute are used in the fountain display. The water is filtered and recirculated.

Cockpit Screen Shows Plane's Position

A navigation device that will permit an airline pilot to see his exact ground position pictured continuously on a cockpit screen was demonstrated before civil aviation heads recently.

The device, called the "Horizontal Navigation Situation Display," projects an image of the plane moving over a detailed map of the terrain below it, on a 5-inch screen mounted on the aircraft instrument panel. The plane image always corresponds to the aircraft's exact position over the ground.

The demonstration of a military prototype of the navigation device was made by the Avion Division of ACF Industries, Incorporated, as part of a 2-day program at Will Rogers Field marking the 20th Anniversary of the Civil Aeronautics Administration and dedication of its aeronautical center buildings. The program, built around the theme of flight safety, was attended by heads of the CAA and the country's airlines.

The 25-pound device, developed and built by Avion, under contract to the Air Force's Wright Air Development Center, automatically correlates aircraft position information supplied by navigation aids in digital form. Through electronic plotting and optical projection, it displays the

plane image and map projection in exact and continuous geographical relationship. Thus, at a glance the airline pilot can see his exact location over the ground, regardless of weather.

The navigation display is said to relieve the pilot of time-consuming mapping chores by giving him a continuous and automatic pictorial presentation of the aircraft's geographical position and flight track, eliminating the need for bulky charts and hand computers.

Aeronautical maps of any area of the world can be microfilmed on glass plates and used as needed, it was pointed out. A very important flight safety feature of this concept is that flight paths, such as the new transcontinental air corridors, can be marked in strips of color or boundary lines forming highways down which the pilot can fly.

With further development, it is possible in the near future to incorporate a warning system which would indicate on the screen the presence of other aircraft, it was added.

The system operates by correlating information fed into it by external navigation computers and other instruments. These signals in turn actuate controls governing the position of map and plane image in relation to each other. The result is projected optically onto a 5-inch screen mounted on the instrument panel where it can be viewed by the pilot.

The system is completely automatic; the only necessity is to make preliminary settings when a new map is inserted in the plotter unit which is done before take-off.

Sea to Fresh Water at Aruba Distillation Plant

Start of production in the world's largest single installation to convert sea water to fresh water has been announced by the Government of the Island Territory of Aruba, Netherlands Antilles. Engineers, who designed and constructed the government-owned plant for the 70-square-mile Caribbean island, say it is the first to combine salt water distillation with production of marketable surplus electricity. The lowered costs resulting from this unique process combination mark a major step forward in man's quest for inexpensive drinking water from the ocean.

Total capacity of the new plant, which replaces a smaller and obsolete unit, is 2.7 million gallons per day of distilled water. This is more than enough to supply the potable water requirements both of Aruba's population of 55,000, and its major industry—the American-owned Lago Oil & Transport Company, Ltd., refinery, with a rated crude capacity of 440,000 barrels per day.

Aruban officials predict that the surplus of water and electricity available from the installation will be a considerable factor in rapid development of the island, where rainfall averages less than 15 inches annually. A 12-acre hydroponics farm has already been built; most of the fresh vegetables and fruits served locally will be products of this farm. In place of soil and rain, the farm uses only distilled water and carefully proportioned nutrient chemicals. Water from the plant is also essential to Aruba's multimillion dollar resort development, which includes a new 125-room luxury hotel and several beach clubs.

Prime reason for lowered water cost is the use of a steam electric plant in conjunction with the distillation units. As in conventional power plants, steam generated in high pressure boilers has most of its energy converted to electricity which can be sold. The exhaust steam from the turbine is not condensed at Aruba, however, but is used to distill the sea water.

Cost figures for water from the new plant have not been released, but Aruban Government estimates indicate a production cost of about $1.75 per 1,000 gallons. When the turbogenerators with their 15,000-kw maximum output go into operation later in the year, exact water cost data reflecting power revenues will be available. These data, as well as the plant's impact upon the island's economy, will be closely examined by planners in regions faced with water shortage problems.

Singmaster & Breyer, New York engineers, who designed and constructed the plant, are affiliated with The Fluor Corporation, Ltd. of Los Angeles, California.

Diagonal Design for Electric Systems

"Diagonal design" is a pioneer feature of the underfloor electric distribution system which will bring complete electrical utility to a new commercial building in Kansas City, Mo. The system, employing more than 130,000 feet of 6-inch H-Duct and 2-inch Nepcoduct supplied by National Electric Products Corporation, Pittsburgh, Pa., is being engineered to bring electric and telephone outlets to all desks, no matter where they are located or positioned.

The diagonal layout is both a departure and an improvement over the ultimate potential of the more conventionally squared, grid-type installation. Laid side by side and joined by saddle supports to form a single installation, the large- and small-size ducts of the underfloor system criss-cross every 5 feet at standard junction boxes installed at the floor level. An assortment of adjustable 2-legged metal saddles are employed at regular intervals to support ducts at the proper height. Large capacity and easy accessibility of junction boxes, installed at floor level, permit additions of both electrical and communications wiring without damage to the floor. Floor-flush location of the outlets provide similar convenience for change and expansion. The main transformer equipment is installed in a special rooftop penthouse rather than at the customary street or basement level.

Primary circuit for the building is 13,000 volts. Feeders of 440 volts are carried to the individual floors from four main buses. Three transformers with a rated capacity of 30-kva on each floor step down the voltage to 267 for building lighting and 110 for desk lighting, accounting machines, and similar electrically powered equipment. Distribution is from six panel boxes on each floor. From these, 32 circuits feed out through ducts to the underfloor system and individual outlets. Use of the unusual 267 volts for lighting will make possible the installation of more lights on each of the circuits with a reduced use of copper wiring.

CLOSEUP of underfloor metal raceways shows junction box components of the National Electric Products Corporation's underfloor ductwork. In the foreground are special-access T units that feed into ducts carrying telephone and intercommunication conductors.

Safety Rules for Backyard Rocketry

In Floydada, Texas, recently a high school chemistry instructor was killed and several pupils injured when a miniature rocket—being employed in a demonstration—exploded.

In Brooklyn, N.Y., at about the same time, a 14-year-old youngster blew three fingers off his right hand while compounding rocket fuel.

These incidents highlight—on a small and amateurish but still deadly scale—the inherent dangers, and the resulting need for more safety, in our age of launching rockets and missiles.

These backyard efforts to learn the mysteries of space followed home style safety rules. Amateur rocketry—on a limited and well supervised scale—is possible. But, amateur safety is not.

"Homemade rockets, loaded and launched with homemade fuels, are tricky and dangerous," according to a statement attributed to G. P. Sutton, president of the American Rocket Society. "They can explode and kill."

Dr. Wernher Von Braun, technical director of the Army Ballistic Missile Program, is reported to have said that "even scientific and professional rocket engineers don't work with live ones unless they have to."

The miniature rockets used by amateurs vary in length from one to five feet. Their real-life counterparts, like those being tested at the Air Force Missile Test Center in Cape Canaveral, Fla., are more than 70 feet in length and contain highly intricate control systems as well as propellants that are explosive and inflammable.

At Cape Canaveral safety measures are

based on as much scientific and engineering research and study as is accomplished by scientists and engineers in missile design and launch.

Typical of these safety measures is the blockhouse, constructed of tons of concrete and steel, located several hundred feet from the launching pad.

The lack of injuries is also attributed to tons of safety equipment employed at the missile test center. Much of this equipment is identical to that used for years in chemical, petrochemical, petroleum, refining, mining, and other industries.

U.S. Air Force base equipment includes M-S-A Shockgard hats, escape masks, hose masks, acid suits, Explosimeters, Chemox, air masks, all-service masks, industrial masks, and Pneolators (automatic artificial respiration devices).

Many manufacturers involved in rocket and missile design and construction maintain modification centers and supply depots at Cape Canaveral.

In addition to this standard safety equipment, five specially-designed infrared gas and liquid analyzers are provided that serve as continuous and accurate monitors of the hydrocarbon content in the liquid air, nitrogen, and helium streams with which rockets and missiles are pressurized. Should the hydrocarbon content of any of the streams approach a critical explosive point, these analyzers—Liras—by means of mercury contact switches, shut down the complete operation instantly. Three Liras are located on the launching pad. The other two are mounted in a hangar used for assembling rockets and missiles for launching.

Flight Efficiency and Safety Measures

Civil Aeronautics Administration. Two new policies of the Civil Aeronautics Administration (CAA) which were determined during the past summer—marking of all CAA aircraft with fluorescent paint, and use of Greenwich Mean Time for all domestic air traffic control operations—have been implemented.

The use of daylight fluorescent paint on the CAA's 92 aircraft and the design of the marking was approved by the Air Coordinating Committee in conjunction with the program being carried out by that body on the order of President Eisenhower to take all possible steps to solve the air safety problems. It was felt that the greater visibility resulting from fluorescent-marked aircraft would reduce the possibility of midair collisions. The action was taken following a successful experiment in which a CAA *DC-3,* painted with a "light-reflecting" paint on the nose, tail surfaces, and wing tips, proved the aircraft was more easily seen against any background and under most light conditions.

In the new design, which uses orange fluorescent paint with a black border, the wing tips are covered and two wide stripes are painted on the upper and lower wing surfaces. The entire tail assemblies are painted, and there is a wide stripe along the underside of the aircraft (see illustration) as well as the side of the entire fuselage. Aircraft not carrying airborne radar equipment are painted on the nose; this is omitted from radar aircraft because fluorescent paint interferes with radar signals.

Adoption of Greenwich Mean Time (GMT) by the CAA was designed to standardize the time element on a nationwide basis to avoid the possibility of errors or misunderstandings by controllers and pilots as aircraft pass through the various time zones. Standardized time is much more easily and successfully used in the electronic computers with which the CAA is starting to equip air route traffic control centers.

It was further noted that the programs of the airlines and the military services to increase their participation in instrument flight rule (IFR) operations have been co-ordinated and agreed upon in order to provide maximum and equitable use of the present capacity of the CAA air traffic control system. Both the airlines and the military have expressed their desire to make maximum use of full IFR in controlled airspace, including climbs and descents between the airport and cruising altitude by both jet and conventional aircraft.

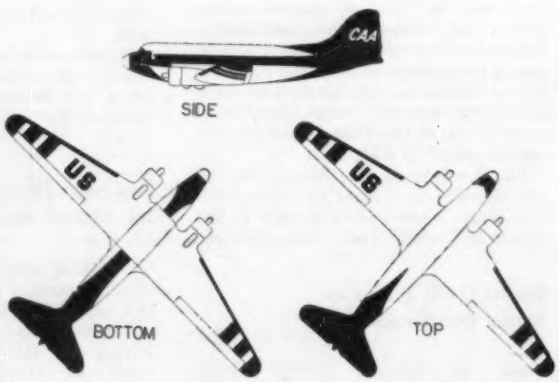
In co-ordinating these programs, the CAA felt it necessary at this time to request the military services to defer maximum use of full IFR climbs and descents, as well as to refrain from a policy of requiring full en route IFR operations by conventional aircraft below 10,000 feet. The deferment of maximum IFR operations will be partly compensated for by concerted attention to provide better departure and approach arrangements for military air bases and airports on which military units are based. In some cases, this will require a modification of jet penetrations, approach and departure procedures, and airway structure at these locations.

Airways Modernization Board. The use of special, high-visibility paints in various experimental configurations to improve the conspicuousness of aircraft was announced by the Airways Modernization Board (AMB) as one of the anticollision aids to be tried in their flight safety program.

A working group was formed to investigate visual techniques and regulatory measures that may further improve flight safety. These will include, together with high-visibility paints, such things as high-intensity flashing and rotating-beam lights of different frequency, color, and locations on aircraft; day- and night-light intensities; generation of smoke trails or puffs behind an aircraft; radio; radar; and altitude separation.

In another development, a major step forward toward solution of problems in communication between en route aircraft and the ground-based control system that is required for the national system of aviation facilities was initiated by development of an AGACS (air/ground/air communications system) directed to greater simplification of the controller's communicating task to permit greater decision-making capability under the AMB's supervision.

The need to achieve time and radio frequency spectrum economies—seriously limited in the present system of voice communications because of the capacity required to handle growing civil–military air traffic movements—necessitates a communications system that permits a higher degree of co-ordination between the air environment and the ground-based, man-machine complex involved in air traffic control system handling traffic over multilayer, multispeed, one-way airways.



AIRCRAFT operated by CAA are marked with orange fluorescent paint bordered in black, as shown, to increase visibility and reduce collisions.

The AGACS is a digital, time-division, multiplex system in which interrogation and replies from the aircraft will be done automatically, and one that is compatible with the present inventory of general aviation, airline, and military vhf (very high frequency) and uhf (ultrahigh frequency) voice communication equipment. Conversion equipment for AGACS operation would be added to existing transmitters and receivers in use, but availability of these same equipments for regular voice operation would be maintained.

A pilot flying a data-link equipped aircraft would, sometime while between fix positions, insert into his equipment the next fix he is to fly over. When he actually passes over the fix, he would push a button which would automatically insert the time and ready the equipment to transmit.

When the aircraft is next interrogated during the automatic rollcall, the information inserted would be transmitted. After

receiving the fix report, the ground equipment would send back automatically an acknowledgment of receipt. Altitude would be sent automatically.

Ultimate aim is to feed replies directly into the data-processing storage system where normal fix reports would be checked automatically and aircraft replies on a Flexowriter would prepare a printed copy of the information.

The present AGACS schedule calls for availability by August 1, 1959, of initial ground equipment and an airborne counterpart capable of being flown and operated in an aircraft.

Development of the AGACS is being carried out by the Communications Division of the Development Directorate of AMB under Major L. C. Wright, acting director. W. R. Deal is project manager for AGACS.

India Invests in Nuclear Energy Power

Stressing a full atomic energy program in preference to its conventional energy resources in its long-term plans for electric power supply calling for the development of 425 million tons of coal equivalent by 1975, India's unique reasons for its decision were revealed in an industrialization program report which appeared in International Energy Reports on United Nations (UN) Economic Developments, published in New York, N.Y., by Worldmark Press, Inc.

Details were based upon a study recently made and submitted by the Indian delegation to the UN Economic Commission for Asia and the Far East. In the report, the difficulties encountered in the transportation of coal to the major power-consuming centers were cited.

The delegation reported that in areas remote to coal fields, atomic energy can provide electric power with less burden to the economy than coal. The government believes that nuclear energy will be competitive in a major part of the country in a short time.

In India, known reserves of uranium and thorium are equivalent in energy value to more than 30 times the reserves in coal. Because of this, its capital investment in uranium production is comparable to its investment in coal production, and the government has stepped up its program to train atomic energy scientists and technicians. India's first reactor, at Aspara has been in operation since 1956. Two new ones are expected to be put into operation by the end of 1958.

Automobile Safety Features Electronic Controls

Magnetic Path. An electronic chauffeur may drive the car of the future, but right now, human drivers still can do a better job, it was reported in a paper delivered at a Columbia University Arden House Conference on electronic control and traffic safety by J. B. Bidwell of General Motors (GM) Research Staff. His comments were based on tests with two GM experimental vehicles, a Unicontrol car that is steered, accelerated, and braked by a single "stick" control, and a car that is steered automatically by an electrical or "magnetic" path produced by a cable in the pavement.

Mr. Bidwell said statistics indicate about 96% of fatal and nonfatal auto accidents result from driver error, and it is suggested that automatic control systems might reduce this percentage drastically. However, he explained, National Safety Council records show that only one accident fatality occurs for each 16 million miles of vehicle travel or approximately every 400,000 hours. "Therefore," he said, "if failure of an automatic control system might be expected to cause one fatality, system failures must not occur more frequently than once per 16 million miles or 400,000 hours to maintain a safety record as good as at present." "Even if less than $25 property damage is assumed as the consequence of system failure," he added, "these might not occur more frequently than once every 165,000 miles or 4,000 hours to be as safe as drivers are now."

The writer said any control system that substitutes for the driver must not conflict with basic advantages that privately owned cars now hold over other forms of transportation, such as: (1) convenience—direct service between origin and destination with departures at any desired time; (2) flexibility—ability to change plans en route; and (3) comfort—pleasant environment with no need for transferring personnel or baggage between origin and destination.

"Automatically controlled cars must maintain or enhance these advantages," Mr. Bidwell declared, "and perhaps provide additional ones . . . Specifications for completely automatic control systems indicate that equipment will be needed both on the road and in the car . . . the most practical means being to provide vehicle guidance by utilizing a magnetic path produced by a current-carrying wire in the road coupled with a suitable sensing means and a steering-control system."

Automatic control of urban traffic, he admitted, poses the most difficult driving problems. Cars would need very complicated decision-making equipment for completely automatic control. Thus, the most feasible initial application of automatic control will be on limited access highways which can handle both manually and automatically controlled cars. If such a system is practicable, motorists could lease automatic equipment for trips on "automatic" highways.

Warning Device. Radar that automatically warns an automobile driver of traffic hazards is now undergoing tests under actual road conditions and a production version of the device is under development, a conference of safety experts was told recently.

In another report presented to the Conference on Electronic Controls and Highway Safety last May sponsored by the Safety Education Institute, Teachers College, Columbia University, engineers of the Research Laboratories Division of Bendix Aviation Corporation, Detroit, Mich., described the new device and said its manufacture presents "no real difficulty."

The Bendix development features a radar antenna about the size of a hollowed-out steak platter mounted in the front radiator grill of the car. The antenna sends out signals which are converted into an automatically regulated "beep-beep" sound that tells the driver whether he is closing the gap too rapidly between his car and the one in front, approaching an object on a possible collision path, or cross traffic threatens collision.

If a motorist is overtaking another car at moderate speed, or if the other car is still some distance away, the "beep-beep" warning is very light, but becomes progressively louder as the other car gets nearer.

Design refinements already accomplished with the new device limit the signals to objects within the car's safe stopping distance, ignore situations in which the car in front is within dangerous distance but is pulling away, permit adjustment for open-country or congested-traffic driving, and reduce background noises that would confuse the signal. The unit does not depend on other cars having complementary equipment or upon any special highway equipment. The auto radar system is reported to be easily adjustable to fit into other electronic aids that may be adopted in the future.

AEC Notes and Developments

General Managership. Pending the retirement of Maj. Gen. Alvin Luedecke from the U.S. Air Force, assistant general manager Paul Foster has taken over the duties of general manager of the Atomic Energy Commission (AEC). J. A. Hall will assume the tasks of acting assistant general manager, and A. J. Vander Weyden that of acting director.

Division Director Resigns. The director of the Division of Reactor Development, W. K. Davis, resigned his position effective July 31.

Historical Committee. Establishment of an Historical Advisory Committee of outstanding historians, scientists, and public administrators was initiated recently with a meeting to discuss plans for the preparation of an official history of the AEC. Members include: Dr. J. P. Baxter, 3rd, president of Williams College (chairman); Dr. G. T. Seaborg, professor of Chemistry, University of California, Berkeley; Dr. A. H. Compton, professor of philosophy, Washington University, St. Louis; Rear Adm. S. E. Morison, historian U.S. Naval Operations, World War II; D. K. Price, Jr., vice-president, Ford Foundation, New York, N. Y.; and Dr. J. L. Cate, professor of history, University of Chicago. The AEC history will be written by a small group of professional historians on the AEC staff, under the direction of Dr. R. G. Hewlett. Preliminary plans call for an unclassified nontechnical but authoritative history to be published in several volumes.

Automatic Shut Down. A reactor safety "fuse" which automatically shuts down high nuclear research reactors if operating control is lost, has been designed, built,

and successfully tested for the AEC by Atomics International, Division of North American Aviation, Inc. A safety device designed to provide absolute protection by shutting down pool type research reactors without the use of external controls should an abnormal operating condition occur, the fuse was tested recently at the AEC's experimental facility known as special power excursion reactor test (SPERT), at the National Reactor Testing Station, Idaho. The fuse prevented the reactor power from rising excessively during a severe transient in which the rate of power increase was tripling each one hundredth of a second, terminating the power surge at a level 25 times lower than the reactor would have reached without the device. Completely self contained, the fuse requires no operator or external connections. It includes a cylinder, part of which is the reactor core. The part outside the core contains boron trifluoride gas. In the event of a reactor transient, or an excessively high level of operation, the gas is automatically released into the other part of the cylinder, absorbing neutrons needed to maintain nuclear chain reaction, and thus bringing the reactor under control.

Norwegian Grant. Approval of a grant of $350,000 toward the cost of a nuclear research reactor project being undertaken by the Institutt for Atomenergy, an agency designated by the Norwegian Government for research and development in nuclear energy. The reactor is a zero-power, pool type facility fueled with natural uranium and moderated and cooled with heavy or light water.

Rocket Propulsion Study. The completion of the assembly of an experimental reactor to be used in Project Rover, a study by the Los Alamos Scientific Laboratory to determine the feasibility of nuclear power for rocket propulsion, has been announced. The reactor, known as KIWI-A, will be tested late in 1958 in initial static ground experiments.

Gamma Irradiator. Construction of a large gamma food irradiation facility to become part of the U.S. Army Ionization Radiation Center, Sharpe General Depot, Lathrop, Calif., has been announced by the AEC. Curtiss-Wright Corporation, Princeton, N. J., is to develop, design, construct, and test the unit, then turn it over to the Quartermaster Corps in connection with its food preservation project. The high-intensity food irradiator (HI-FI) will have a source of radiation that will be approximately 2 million curies of radioactive cobalt-60.

Boron-10 Distribution. A revised plan for the commercial distribution of boron-10 materials has been put into operation recently. Enriched up to 92% in the isotope B-10, boron will be distributed by the AEC Chicago Operations Office. This type enriched boron is in the form of elemental boron and the compound potassium fluoborate. Boron enriched to a greater degree than 92% B-10 may be obtained in small quantities from the Oak Ridge National Laboratory. Many other special boron-10 compounds are also available from the Oak Ridge facility.

Uranium Restrictions Lifted. Prohibitions on non-nuclear uses of uranium have been removed, and depleted uranium from AEC stocks now are available for sale on an unclassified basis. Price schedules and general terms and conditions applicable to sales of depleted uranium in the form of uranium hexafluoride were published in the Federal Register on June 28, 1958. A copy of the notice can be obtained from the AEC Materials, Services, and Information for Civil Applications Department, Washington 25, D.C.

Ship Reactor Development. The AEC and the Maritime Administration have contracted General Dynamics Corporation for development work in connection with a gas-cooled nuclear power plant for merchant-ship propulsion. This type of propulsion would weigh less than other types of nuclear power plants and would operate safely in port and at sea.

Life Science Research. Award of 64 unclassified life science research contracts in the fields of medicine, biology, environmental sciences, radiation instrumentations, and special training has been made to universities and private institutions in a continuing policy of assisting and fostering research and development in fields related to atomic energy. New projects total 25. Renewals total 39. A detailed list of the awards is available from the AEC.

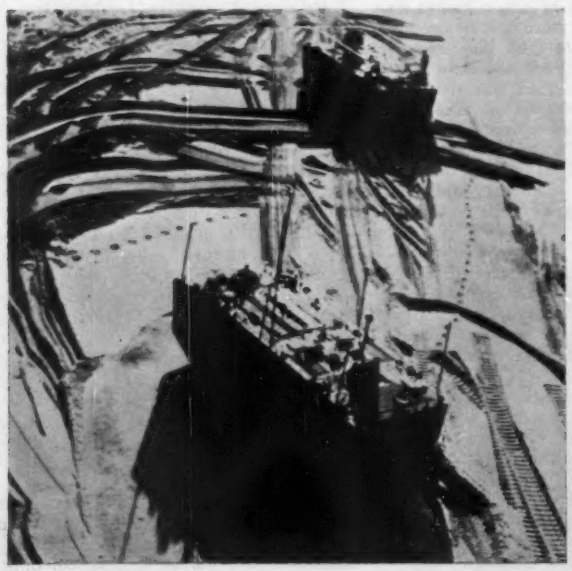
Radiation Incident Services Available. State and local government officials have been notified that the AEC and the Department of Defense have special services personnel available should an incident involving radiation occur. Advice and assistance can be obtained from the nearest AEC or military installation. A map of the regional locations and a listing of offices can be gotten from the AEC, P. O. Box 59, Lemont, Ill.

Chinese Reactor. The U. S. Government contributed $350,000 toward the cost of a nuclear research reactor project being undertaken by the Republic of China through its Ministry of Education and Atomic Energy Council. The reactor will be located at the Institute of Nuclear Science of National Tsing Hua University at Hsinchu, about 40 miles southwest of Taipei, Taiwan (Formosa).

Reactor To Investigate Fuel Elements. A unique nuclear reactor, to investigate the effect of extreme nuclear conditions upon fast reactor fuel elements, will be completed during 1958 at the AEC's National Reactor Testing Station, Idaho Falls, Idaho. The unit, called TREAT, is designed to deliver a high-intensity short-duration pulse of nuclear energy without damage to the facility itself. It will be fueled with uranium oxide dispersed in graphite as a moderator.

USMC Tests Radio-Controlled LVT

Remote-controlled amphibious landing once may have been considered a dream—but not any more. On Pacific beaches at



MARINE CORPS amphibious assault vehicles *(below)* churn toward California shore under electronic control of helicopter-borne driver. Remote control works equally well on land or water. Two electronically operated *LVTP5's (left)* are put through their paces on the beach to test the system.

Camp Pendleton and Monterey, Calif., U. S. Marine Corps (USMC) personnel has been surf-testing amphibious vehicles controlled by radio from helicopters hovering overhead. In this technique, the "driver" guides Marine *LVT*'s (Landing Vehicle, Tracked) with a portable electronic control panel. By moving a steering stick, similar to an aircraft control stick, and by manipulating buttons and switches mounted on the panel, the driver can start and stop the engine, steer, shift gears, brake, and apply the throttle. In short, he can operate the vehicle almost as well as if he were seated at the manual controls —and he can see better.

The radio control system was developed for the Marine Corps by Lear, Incorporated, Grand Rapids, Mich., an electronics firm, to assist the Marines in putting their newest amphibious vehicles through rugged surf tests without endangering human lives. The California tests were successful.

Electronic Impulses Converted to Printed Words

A device which can receive messages automatically and assemble the electronic impulses into printed characters and words at a speed of 30,000 matrix characters per second has been developed recently. Produced by the Burroughs Corporation, Detroit, Mich., the technique lends itself to producing either matrix or preformed characters, and is described as "electrographic recording."

Products based on this technique, for which several applications are now being worked out, produce controlled, visible dots by direct electrical impulse means. In its essentials, the process utilizes a controlled source of electricity to form small charged areas on a high-resistivity surface such as a coated paper. The electrostatic latent image formed by the charged areas is made visible by application of powdered ink, permanently fixed by the application of heat.

The recording head comprises 35 tiny wires leading into and through a triangular-shaped piece of plastic. The wires are polished flush with one corner of the "triangle," or printing head, to form a rectangle seven wires high by five wires wide. A printing line is formed by the arrangement of 72 matrixes in a row. They do not touch the paper but are maintained at a fixed distance from the paper surface. Electric pulses will selectively charge all 35 wires or any combination of those wires in each head. A normal line of type is made possible by setting up the first character in the line across all 72 heads. The only head that prints is the one selected by a coincident pulse to the back plate, or "anvil." The electrostatic charge can be deposited in one microsecond.

During the recording stage, the electrical discharge from the printing head to a metal plate—grounded or of polarity opposite that of the printing head—is used as the source of charge to form the electrostatic latent image on the paper surface. The size of the image depends mainly upon the polarity, the electric field strength, and the surface coating used on the paper. A relatively low negative voltage applied to the point electrode gives small, round dots. Permanent recording with no fading is achieved. By eliminating the inking and fixing steps, the paper can be erased and used over again or can be "read" electronically by picking up the electrostatic charge.

Flight Operations Center Aids Army Tactical Aircraft

Aircraft traffic in any combat area will be controlled by a highly mobile Flight Operations Center (FOC) developed by the U. S. Signal Corps.

The announcement of the FOC was made recently by the Department of the Army. The flight control system, a result of work at the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., is mounted in military vans and trailers for tactical use in battle zones. Communications experts in the Signal Corps believe the system may provide new ideas for other military and civil aviation authorities working toward safer and faster flight control.

Emphasis is placed on the important defense role of Army aviation—both fixed-wing aircraft and helicopter—for artillery fire control, observation, troop and materiel movement, rapid transport of wounded men, and many other missions.

Differing from familiar air control towers, the FOC's are designed to regulate aircraft en route between points, rather than at landing and takeoff. In its primary role as a service to aviators, the FOC clears a pilot's flight plan before takeoff and then provides him with in-flight assistance from origin to destination.

Control caravan nucleus is a 30-foot operations van. Other mobile units include a radio equipment shelter and two trailer-mounted diesel generators to permit uninterrupted operation while one generator is serviced or repaired. All vehicular units can be airlifted or placed aboard ship. The control van is waterproof and can be floated ashore without landing craft at a beachhead. In operation, a highly trained staff keeps tabs on aircraft in its assigned sector of sky, knows where planes are going, what they are doing, and what hazards they are encountering.

Working with other control centers and ground installations, they co-ordinate flights under instrument or clear-weather conditions, keep in touch with pilots in the air, compile information on identification of friendly and hostile aircraft, and of enemy ground locations. Close liaison is kept with antiaircraft missile and gun batteries.

Information from the 10-foot traffic control console is used on a plotting board on which magnetic aircraft symbols are shifted to give an up-to-the-minute flight picture of the area's entire moving aerial skein. An overlay sector map and an aircraft route chart are posted, in addition to current status of all navigational aids. Four radio sets including FM are used. Heat and air conditioning enable men and equipment to function efficiently at —60 or +140 F.

U. S. Army Photograph

FLIGHT CONTROL VAN built at U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., is operated by highly trained men who keep fingers on pulse of Army tactical aircraft. Mobile unit, with 10-foot communications and flight-charting console, keeps tangles out of complex moving web of fixed-wing aircraft and helicopters. SP3 Charles Bowen (foreground), assistant flight controller, receives flight plan. SP3 R. W. Parton (center) posts plane's progress from one beacon to next. Capt. Clancy Faucheux, Flight Operation Center commander, computes ground speed from data on air speed and wind velocity and direction.

Medical Aids Through Electronic Devices

Advances in Prosthetics. A prediction that compact electronic substitutes may some day replace defective human organs and limbs was made recently by Brig. Gen. David Sarnoff, chairman of the board of the Radio Corporation of America (RCA).

In an address before the World Congress of Gastroenterology, General Sarnoff also envisaged a day when electronic devices would help the blind to "see"; control movements of an artificial arm, leg, or even fingers with precision; aid scientists in their search for a cancer cure; and bring the best medical advice to any part of the world by television. In the field of orthopedics, although electronic methods are not yet at the point of major utility, "important possibilities are in evidence," he said.

He noted the electronic apparatus for systematic and automatic exercise of any part of the body—in cases of partial paralysis, for example—which are already far advanced. The electronic capacity to amplify the most minute muscular efforts and impulses to almost any desired magnitude holds promise for improvement of prosthetic devices, he feels.

Citing the constant advances in electronic equipment for large audio amplification for the nearly deaf, General Sarnoff went on to describe devices, now at the experimental stage, that in some measure "see" for the blind. Beginnings have been made, for example, toward electronic detection of obstacles in the path of the blind or sudden changes in the ground or pavement levels. "Progress is being registered," he said, "in electronic equipment for translating ordinary type into audible signals, thus enabling the blind to 'read' conventional printed matter."

Skull Measurement Identification. A new means for instant identification of war or disaster victims through electronic computer handling of skull measurements was reported at the University of Pennsylvania. The technique, being published in article form in *The Journal of Forensic Sciences* after presentation before Boston and Cleveland scientific groups this spring, was developed by Dr. Viken Sassouni, an assistant professor of physical anthropology in the University's Graduate School of Medicine and a graduate student in the School of Dentistry there.

Although details as to application of the technique remain to be worked out, Dr. Sassouni's method was seen as a potential major aid to military, police, insurance, and disaster relief organizations in identifying the dead. Dr. Sassouni collected 500 pairs of frontal X-rays and then developed eight measurements which are highly individual. The figures for all 500 X-rays were coded into the "memory unit" of the Univac system. When a participating faculty member chose a particular foot-square negative from the simulated after-death file, Dr. Sassouni made eight quick measurements. He fed the coded results into the Univac, which promptly delivered directions for finding the corresponding X-ray picture in the before-death file. The entire procedure took two minutes and 16 seconds.

The vital measurements in Dr. Sassouni's roentgenographic cephalometry process are: bigonial breadth, mastoid to apex height, bimaxiliary breadth, bizygomatic breadth, maximum cranial breadth, sinus breadth, incision height and total facial height. Dr. Sassouni stressed that further thinking must be done before the method can be widely useful. He is also proposing a portable picture-taking unit which could X-ray the victim's skull at a standard angle under any conditions. Technicians could be trained in a brief time to read measurements properly from the X-rays.

In this manner, a catalogue of personal measurements could be built up at a central office—just as the F.B.I. has a massive fingerprint file. Coded equivalents could be telegraphed from the field, and proper identification made at the center and relayed back to the field workers at once.

The research upon which his new discovery was based has been supported at the University of Pennsylvania by the Quartermaster Research and Development Command of the U. S. Army.

Metals Sprout Crystalline "Whiskers"

In 1948, the presence of "metal whiskers" became known, a discovery which explained, if it did not solve, the previously baffling erratic behavior of electronic equipment. Such equipment might be inoperative in the field, but might work perfectly in the laboratory.

The "metal whiskers," crystalline in structure, are found on tin, zinc, and cadmium surfaces. They can grow at the rate of as much as $\frac{5}{8}$ inch per year. Invisible to the naked eye, they are actually thin-walled brittle tubes when viewed through a microscope. They can thrust their way through paint and insulating material.

These crystalline growths would be able to short circuit equipment in the field, but during transportation to the laboratory would be broken off and so render the equipment operative again.

Since 1948, considerable research has been done in an effort to eliminate these whiskery troublemakers ("Strange Crystals May Explain Steel Failure," *Electrical Engineering*, Jan. 1958, p. 112). Shown on this month's cover is a Boeing Airplane Company technician examining a growth of "metal whiskers" on a potentiometer through a stereomicroscope. The potentiometer is encased in a glass cube which is open at the top, and a current of air is directed downward onto the metallic growth.

The air jet causes these "whiskers" to wave, allowing them to shimmer in the back-light and thus become visible through the special microscope.

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Subsurface Current Measured by Scientists

A new "river in the sea" 250 miles wide and 1,000 feet deep has been mapped by scientists of the University of California's Scripps Institution of Oceanography and the U.S. Fish and Wildlife Service's Pacific Oceanic Fishery Investigations.

Unlike the well-known surface currents that appear on maps of the oceans, this is a subsurface current. Measurements show that it is as strong as a thousand Mississippi Rivers and as swift as the Atlantic Gulf Stream. This newly discovered current flows eastward along the equator for at least 3,500 miles.

Under the auspices of the National Academy of Science's IGY Committee, the research vessels *Horizon* of the Scripps Institution and *Hugh M. Smith* of the Pacific Oceanic Fishery Investigations recently spent almost two months at the equator.

The cruise was called the Dolphin Expedition. Using a technique developed at Scripps, Dolphin Expedition anchored a buoy in water nearly three miles deep located at longitude 140° west and the equator.

Using a Japanese technique of fishing lines attached to a rope several miles long, the research vessel put out its buoys and discovered that the lines did not move westward with the surface current, as anticipated, but in a rapid opposite direction. Other buoys were established one and two degrees north and south of the equator. These five buoys served as reference points for the subsequent measurements of the current.

The equator "buoy" was tended by one of the vessels continuously for a 22-day period. Only 100 feet beneath the west-flowing South Equatorial Current at the surface, the expedition located and measured the very rapidly east-flowing subsurface current.

Originally discovered in 1952 by a U.S. Fish and Wildlife Service expedition, the current was studied more extensively by the Dolphin Expedition which found that it extends east to the Galapagos Islands; that its core lies about 300 feet beneath the surface, becoming shallower toward the east; and that it is about 250 miles wide, 700 feet thick, with a speed of about three knots—more rapid than the surface current.

On the second half of the expedition, *Horizon* sailed eastward along the equator, making current measurements every 180 miles. The core of the current gradually lifted until it was approximately 140 feet beneath the surface. Santa Isabela Island, in the Galapagos Islands, sits astride the equator. To the west of the island of Santa Isabella the current was still traceable, but to the east of the island, it had disappeared.

According to J. A. Knauss, Scripps oceanographer, the newly discovered current "is probably an important mechanism in making the equatorial waters one of the fertile pastures of the oceans, where fishes and other marine animals are unusually abundant."

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, *Electrical Engineering* reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Illustrations should be submitted in duplicate, one copy and inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Pump–Turbine Story

To the Editor:

In the introduction to my article "The Pump–Turbine Story," which appears in the July 1958 issue of *Electrical Engineering*, you state that pump turbines are commonly used in Europe. It was unfortunate that the block paragraph put the wrong meaning on the entire story. As a matter of fact, the Western Hemisphere is the only place where there are any pump turbines. The article states in the first paragraph of text that "pump storage" has been in use in Europe for more than 75 years, not pump turbines.

As stated, the Europeans use pump-storage units which have a separate hydraulic turbine and a separate centrifugal pump with a generator motor mounted between them. The reversible pump turbine which was principally developed in the United States is a single machine used for pumped storage which runs in one direction when operating as a turbine and in the reverse direction when operating as a pump.

Very truly yours,

F. E. JASKI

(Engineer-in-Charge Pump Turbines, Hydraulic Department, Allis-Chalmers Manufacturing Company)

USSR EE Education and Research

To the Editor:

In commenting upon the very able study of Dr. P. A. Abetti and of G. F. Lincks (*Electrical Engineering*, May 1958, pp. 384-90, and June 1958, pp. 479-84) I would like to say first of all that they have indeed made a very fortunate choice in picking on a narrow topic—electrical engineering education and research—which is viewed and evaluated by competent practitioners in a given field. It is this type of evaluation, namely, professionals rating professionals, which is needed. Particularly valid are the first-hand experiences and observations which can be gained mainly through exchanges, participation in professional meetings, etc. We cannot but gain knowledge from such exchanges. If the Federal Government and philanthropic foundations do not provide sufficient financial support to widen such exchanges, it is the job of individual corporations to come forward, not only in terms of dollars, but particularly in terms of leadership and initiative. We are often amiss in letting laymen amateurs tell us what is worthwhile in Soviet technology, what is good or bad in Soviet research and technical education efforts. The value to us of exchanges between professionals cannot be too strongly emphasized.

In regard to the numerical picture on the training of engineers in the USSR, I would like to note that because of specialization and a certain fragmentation of training, it is difficult to be precise as to how many electrical and power engineers are trained in the Soviet Union. But that in the last 7 years the engineering enrollment in Soviet higher education has better than doubled—from 321,000 in the Fall of 1950 to 720,000 in October 1957—is a very hard and indeed very distressing fact.

In 1955, the last year for which comprehensive Soviet breakdowns of engineering graduates are available, the field of power engineering accounted for 4,957; electrical machinery and equipment, 2,981; and radio and communication, 2,950; out of a total of 66,000 in all engineering fields. Enrollment in Soviet engineering schools today comprises about 40% of all students in higher education, which shows a 10% increment in the relative share over 5 years ago, then 30%. This year (1957) the USSR turned out about 80,000 engineering graduates, a figure which can hardly be sneered at.

What is particularly important about these numbers is that the factual data presented by Abetti and Lincks, and their evaluation of the programs and their quality, suggest that USSR engineering training is not bad at all. Some of the things the Soviets do in curricular matters may not be to our liking, and there are some rigidities and practices in their training practices which would not make our educators and employers very happy. But we should not be distracted by a view of poor shrubbery when looking at a house basically built on a sound foundation. Whatever faults might be found in Soviet education at large, the science and engineering side of it, as the authors show, is indeed quite solid. And the problem which this poses for us is—How can we gain some of the solidity and betterment in our own educational programs for science and engineering, preserving at the same time the precious heritage of our democratic educational ideals?

NICHOLAS DE WITT

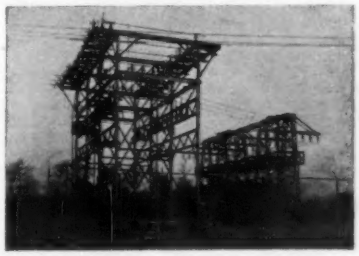
(Associate, Russian Research Center, Harvard University, Cambridge, Mass.)

Earlier Prefabricated Substation

To the Editor:

We were quite interested in noting on page 627 of the July 1958 *Electrical Engineering*, the several pictures and story on the Consumers Power Company substation, fabricated by Handley-Brown Company. Someone apparently has neglected the historical facts when quoting this as one of the world's first prefabricated all-aluminum substations.

Actually the first prefabricated, all-aluminum substation was erected in December of 1945. In the summer of 1945, we in Greensburg fabricated what was known as the world's first all-aluminum substation for the Pennsylvania Electric Company. This substation consisted of two structures, photographed on December 1, 1945, print 2996P attached.



All the vertical A-frame structures and connecting trusses for the 34.5 kv high voltage side, and the switch base trusses of the 7,500 volt, beam structure were factory preassembled and shipped to the job site. Practically no ground work was required, and erection time was kept down to a matter of hours.

We are curious to know who may have assumed that the above reference on page 627 was factual. Ten years ago we published the same statement, and now are merely attempting to set the record straight. We expect that this was a Kaiser news release and will bring this matter to their attention.

Very truly yours,

ERIC ZIMMERMAN

(Advertising Manager, R&IE Equipment Division of I-T-E Circuit Breaker Company)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ASTM STANDARDS ON METALLIC ELECTRICAL CONDUCTORS. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1957. 334 pages, 6 by 9 inches, paper. $3.75. A collection of standards useful to utilities, wire and cable manufacturers, and to the electronic and communications industry. Materials dealt with include copper, copper alloys, copper-covered steel, aluminum, and galvanized steel and iron.

THE ADMINISTRATIVE PROCESS. By R. H. Roy. The Johns Hopkins Press, Homewood, Baltimore 18, Md., 1958. 236 pages, 6¼ by 9¼ inches, bound. $5. Designed to be of practical help for management in solving administrative problems, this book deals with organization, channels of communications, delegation of authority, operations, analysis, forecasting and planning, resolution of conflict, morale, and criteria for decisions. Written in an informal style with liberal use of examples and ancedotes.

ADVANCES IN GEOPHYSICS, VOLUME 4. Published by Academic Press, 111 Fifth Ave., New York 3, N.Y., 1958. 338 pages, 6¼ by 9¼ inches, bound. $12. Continues the series of broad reviews of sectors of the science where knowledge has accumulated the most rapidly. Approximately an equal amout of space is devoted in this volume to the following five subjects: atmospheric chemistry, theories of the aurora, the effects of meteorites upon the earth (including its inhabitants, atmosphere, and satellites), smoothing and filtering of time series and space fields, and earth tides. Reference lists accompany each paper and the volume is indexed by authors and subjects.

APPLIED MATHEMATICS FOR ENGINEERS AND PHYSICISTS. By L. A. Pipes. Second edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 723 pages, 6¼ by 9¼ inches, bound. $8.75. This book covers a wide range of topics in advanced fields of calculus. The chapters on matrix algebra, Fourier methods, variational methods, Laplace transforms, and nonlinear differential equations have been considerably expanded in this edition. A new section on Cartesian tensors has been added to the chapter on vector analysis. New illustrations have been added, and the number of problems doubled.

ATMOSPHERIC EXPLORATIONS. Edited by H. G. Houghton. The Technology Press, Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 125 pages, 6 by 9¼ inches, bound. $6.50. Papers on the electrification of clouds and raindrops, the formation of electric charges in thunderstorms, the positive streamer spark in air in relation to the lightning stroke, and the phenomena of radio scattering in the ionosphere are included in this volume. The papers were presented at the Benjamin Franklin Memorial Symposium of the American Academy of Arts and Sciences in 1956.

THE ECONOMICS OF INDUSTRIAL MANAGEMENT. By Walter Rautenstrauch and Raymond Villers. Second edition. Funk & Wagnalls Co., 153 E. 24th St., New York 10, N.Y., 1957. 488 pages, 6¼ by 9¼ inches, bound. $7.50. A study of the methods that can be used to provide effective profit control in an industrial enterprise make up this publication. It describes in detail the profit and loss chart, the sales mixture chart, the break-even chart, and the method of differential profit control and its applications. The fundamental principles involved in a study of industrial costs are given and special attention is paid to the use of electronic computers and to the use of mathematical methods in modern industrial management.

ELECTRICAL ENGINEERING PRACTICE, VOLUME I. By J. W. Meares and R. E. Neale. Sixth edition. Chapman & Hall Ltd., 37 Essex St., London, England, 1958. 716 pages, 5½ by 8¾ inches, bound. 60s. The first of a review of current British practice, to appear in three volumes. Volume I, in the first part, deals with definitions, materials, and measurements; the second part covers the generation and sale of electrical energy; and the third part details the transmission and control of electricity, including switchgear and protection of circuits.

ELECTRONIC MEASURING INSTRUMENTS. By E. H. W. Banner. Second edition. Chapman & Hall, Ltd.; The Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1958. 496 pages, 6 by 9 inches, bound. $7.95. An extensive survey of electronic components used in measuring instruments such as tubes, photoelectric cells, metal and crystal rectifiers, and

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ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to: R. H. Phelps, Director, Engineering Societies Library, 20 W 39 St., New York 18, N. Y.

radiation and particle detectors, as well as the electronic instruments using these components. Quasi-electronic instruments are also discussed, and include electronic and related counters, instruments using electromechanical transducers, and instruments for measuring physical quantities.

THE EXPLORATION OF SPACE BY RADIO. By R. H. Brown and A. C. B. Lovell. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 207 pages, 6 by 9¼ inches, bound. $6.50. This book surveys the field of radio astronomical studies, including the radar techniques for the investigation of various aspects of the solar system, as well as the receiving techniques which are used to study the solar, galactic, and extragalactic radio emissions. Specific aspects discussed include the hydrogen line, scintillation of the radio stars, meteors, the aurora borealis, and the radio telescope at Jodrell Bank, England.

FUNDAMENTALS OF SONAR. By J. W. Horton. United States Naval Institute, Annapolis, Md., 1957. 387 pages, 8 by 11 inches, bound. $10. A discussion of acoustics as applied to underwater sound and of the concept of transmission loss is followed, in this volume, by a treatment of electroacoustic transducers, in which the author introduces a method for expressing the integrated effect of variations in transducer response considered as a function of frequency. Also discussed are indicators and recorders, direct listening, and echo ranging.

GRAPHIC SCIENCE. By T. E. French and C. J. Vierck. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 758 pages, 7¾ by 10¼ inches, bound. $8.50. This volume provides an understanding of graphical methods as they relate to the problems of the engineer. The first part deals with engineering drawing, including the fundamentals of projection. The second covers descriptive geometry, including the solution of space problems of points, lines, planes, and surfaces. The third part gives graphical solutions, including nomography and empirical equations.

GUIDED MISSILES. Sponsored by the Department of the Air Force. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 575 pages, 9 by 11¼ inches, bound. $8. A manual on the handling and operation of guided missiles, topics included are: aerodynamics and propulsion of guided missiles as well as the physics involved in their design, guided missile control systems and their components, guided missile guidance systems, trajectory considerations and tactics, and instrumentation. Methods are given for the maintenance and inspection of missiles.

THE GYROSCOPE. By J. B. Scarborough. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1958. 257 pages, 6¼ by 9¼ inches, bound. $6.50. A study of the mathematical and mechanical aspects of the gyroscope are given. Following a discussion of the theory, specific applications are discussed, including vehicles and rotating bodies, direction indicating and steering, stabilizing, and astronomy. Vector methods are used throughout in the solution of problems.

HIGH QUALITY SOUND REPRODUCTION. By James Moir. Chapman & Hall, Ltd., London, England, 1958. 591 pages, 5½ by 8¾ inches, bound. 70s. This book is devoted to the design and performance characteristics of sound reproduction systems including such areas as performance specifications, microphones, magnetic recording and reproduction of sound, voltage and power amplifiers, negative feedback, tone-control circuits, dividing networks, loudspeakers, and stereophonic sound reproduction.

THE IMPACT OF HIGH TEMPERATURE TECHNOLOGY. By V. P. Kovicik and others, High Temperature Associates, 882 Ravine Dr., Cleveland Heights 12, Ohio, 1958. 272 pages, 8½ by 11 inches, paper. $8. This volume gives studies of the present status of high temperature technology, and attempts to indicate possible future developments. Areas covered are nuclear power, propulsion, component equipment, aircraft and missiles, electronics, temperature measurement, high temperature process developments, and materials. The report was written by graduate students under the guidance of the Harvard Business School Faculty.

NONLINEAR CONTROL SYSTEMS. By R. L. Cosgriff. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1958. 328 pages, 6¼ by 9¼ inches, bound. $9. The nonlinear phenomena arising in the area of control systems is covered. Topics discussed include the rise of techniques for linear systems with time-varying parameters for determining the response of control systems, nonlinear systems excited by random input signals, reduction of statistical problems to differential equation form, and application of switching circuits in control systems. The approach to the subject is expedited by the use of the concepts and terminology of automatic-control theory rather than those of classical mechanics.

SWITCHING CIRCUITS AND LOGICAL DESIGN. By S. H. Caldwell. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1958. 686 pages, 6¼ by 9¼ inches, bound. $14. The fundamentals and applications of switching theory are presented. Among the various aspects discussed are switching algebra; switching components and their characteristics, including relays and high speed components; contact networks; gate circuits; and switching aspects of codes. Although the book does not deal specifically with computing machines, the switching theory discussed is fundamental to their design.

SYNCHRONOUS MOTORS AND CONDENSERS. By D. D. Stephen. Chapman & Hall Ltd., London, England, 1958. 500 pages, 5¾ by 8¾ inches, bound. 60s. An introduction to the characteristics of synchronous motors and to the problems encountered in selecting the most suitable motor for a particular industrial application is included in this volume. In addition, information is provided on associated starting and control equipment and on various aspects of protection for synchronous machines. A concluding section discusses synchronous condensers.

WAVE PROPAGATION AND ANTENNAS. By G. B. Welch. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1958. 257 pages, 6¼ by 9¼ inches, bound. $5.75. This book provides a general background knowledge of electromagnetic wave propagation and an analysis of the fundamental principles of antennas. Similarities between optical and radio waves are stressed, and for ease of understanding, graphical methods for obtaining radiation patterns are based on the single principle of interference. Such recent developments as radar, forward scatter, and radio astronomy are included.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

ELECTRONIC COMPONENTS HANDBOOK. Volume 2 of the handbook deals with power sources and converters, fuses and circuit breakers, electrical indicating instruments, printed wiring boards, solder and fluxes, choppers, blowers, and r-f transmission lines and

waveguides. Prepared for Electronic Components Laboratory, Wright Air Development Center, the book was edited by Keith Henney and Craig Walsh, McGraw-Hill Book Company, Inc., and furnishes data on a variety of components widely used in military electronic equipment, as an aid in selecting and applying the best unit for a particular job for maximum end product reliability. This volume describes the types of a given component and the uses of the particular types. It lists unfavorable environment effects on each of heat, humidity, altitude, pressure, shock, and vibration, and concentrates on those kinds of component parts for which a co-ordinated triservice military specification has been written. It also covers other component types for which only single-service specifications or industrial specifications are available. A digest of the military specifications covering each kind of each component is given. The book is available from McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., at $12.50.

SPECIFICATIONS FOR FULL-LENGTH, NON-PRESSURE, PRESERVATIVE TREATMENTS OF POLES (Hot and Cold Submersion Processes). These specifications are one of a series to be issued by the Transmission and Distribution Committee of the Edison Electric Institute, covering various materials used in line construction. They are intended to be used by member companies as an aid in preparing their own specifications for the purchase of these materials. Representing the consensus of a large majority of the industry, they have been prepared after a considerable amount of co-operative study between representatives of the power companies and pole producers. Copies of the specifications, TD-100 1957, may be obtained by writing the Edison Electric Institute, 750 Third Ave., New York 17, N. Y.

SAFE DESIGN AND USE OF INDUSTRIAL BETA-RAY SOURCES. National Bureau of Standards (NBS) Handbook 66, prepared under American Standards Association (ASA) procedures, was composed to serve as a guide toward safe design, manufacture, installation, use, maintenance, and disposal of beta-ray sealed sources for industrial applications. Because of the present rapid expansion of this technology and likelihood of change, the handbook gives a generalized discussion of the many aspects of personnel protection in connection with beta-ray sources, rather than a set of rigid safety rules for their manufacture and use. It is hoped that the information contained herein will help the reader to comply with the radiation protection regulations issued by the U. S. Atomic Energy Commission and other Federal and state agencies. The book was prepared under the sponsorship of the NBS, by the Subcommittee on Sealed Beta-Ray Sources of ASA Z54 Sectional Committee, whose purpose is to formulate safety codes in which basic standards and other appropriate data are applied to industrial radiation protection problems. The book contains a glossary of definitions, and chapters are included on radiation exposure, selection of radioactive materials, prototype testing, instruction manuals, labels, working conditions, accidents entailing radiation hazards, and several chapters dealing with the handling of sources. There are two appendixes: a listing of pertinent laws and regulations, and maximum permissible exposure limits. NBS Handbook 66 may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. (Foreign remittances must be in U. S. exchange and should include an additional one-fourth the publication price to cover mailing costs.)

RELIABILITY STRESS ANALYSIS FOR ELECTRONIC EQUIPMENT. Basic techniques and numerical values necessary to calculate the reliability of complex electronic equipments are contained in this handbook, prepared by the Radio Corporation of America (RCA), and adopted by the U. S. Navy for guidance of its design engineers. The handbook is an engineering design guide to the application of electronic parts and tubes and provides a basis for evaluation of circuitry in terms of failure rate. Included are a discussion of reliability fundamentals and rules for establishing risk values. Procedures are given for failure-rate summation, interpretation of total failure rate from the system viewpoint, and reliability specification and proof. In addition, part-failure characteristics are presented for vacuum tubes, semiconductor diodes, metallic rectifiers, resistors, capacitors, transformers, chokes, coils, motors, connectors, plugs, relays, and switches. The handbook, *PB 131678*, by H. L. Wuerffel, T. C. Reeves, M. P. Feyerherm, D. I. Troxel, and F. A. Hartshorne, of RCA, Nov. 1956, may be ordered from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. It contains 182 pages, price $3.

METALLIC RESTIFIERS AND CRYSTAL DIODES. By Theodore Conti, this book presents basic information on the subject in elementary terms. After introducing the units, the text proceeds to analyze the construction of metallic rectifiers and crustal diodes. Then, characteristics are thoroughly discussed. The text supplies basic design data and covers the applications of these components. Troubleshooting, repair, and replacement are fully treated. Copies, at $2.95, may be ordered from John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y.

13TH CONFERENCE OF THE REINFORCED PLASTICS DIVISION, THE SOCIETY OF THE PLASTICS INDUSTRY, INC. Full technical details on the most significant developments in reinforced plastics in materials, processing, performance, and end uses are available in two volumes published by the Society of the Plastics Industry, Inc. (SPI). The first volume, Preprint Book, contains texts and illustrations of the 72 talks presented at the reinforced plastics Technical and Management Conference; the second volume, Proceedings, comprises a full report on questions and answers engendered at the 16 separate Conference sessions. Some of the topics on which papers were presented are building, boats, tooling, premix materials, preforming and filament winding, high temperature performance, and new materials. The two volumes are available for $7 plus postage. Orders should be sent to SPI, 250 Park Ave., New York 17, N. Y. The Society will ship the Preprint book upon receipt of the order and will invoice at that time; the Proceedings volume will be shipped when it comes off the press.

THE FEDERAL BASIS FOR WEIGHTS AND MEASURES. By R. W. Smith, this is a historical review of Federal legislative effort, statutes, and administrative action in the field of weights and measures in the United States, with particular emphasis on units and standards. Covering the years 1776-1956, the booklet is divided into three sections: (1) The Hassler Era, 1776-1836, (2) The Mendenhall Era, 1836-1896, and (3) The Modern Era, 1896-1956, with a resumé following each. Certain important and closely related administrative actions initiated by Hassler and Mendenhall are cited, and current Federal statutes having weights and measures significance are discussed briefly. In its entirety, the circular presents a connected and reasonably comprehensive story of the Federal contribution to the legislative basis for weights and measures administration in the United States. Published by the National Bureau of Standards as Circular 593, the booklet is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30¢.

LIGHTING HANDBOOK. Published by the lamp division of Westinghouse Electric Corporation, the handbook is designed to serve engineers, architects, electrical contractors, and lighting designers as a comprehensive lighting design manual. Containing 256 pages, the handbook includes a fold-out page in full color of the electromagnetic spectrum, information on distribution and light measurements, a revised section on the newest light sources, information on coefficients of utilization and maintenance factors, tables of recommended lighting levels, and many illustrations. Other topics discussed are interior wiring, school and office lighting, store lighting, industrial and architectural lighting, floodlighting design, street and sign lighting, germicidal and sun lamps, and lighting economics. Copies of the handbook may be purchased from the Westinghouse Lamp Division, Bloomfield, N. J. The price is $3 prepaid.

GLASS ENGINEERING HANDBOOK. By E. B. Shand, technical consultant, Corning Glass Works, this is an informative volume on the composition, manufacture, properties, and applications of glass as an engineering material. It gives practical data on the use of glass products in industry, research, and various fields of manufacturing including electron-tube manufacture, the nuclear field, guided missiles, and the automotive field. This revised, Second Edition includes new data to meet the needs created by the increased engineering and industrial applications of glass. In addition to coverage on the more commonly known glasses, there is information on such topics as photosensitive glass, glass-ceramics, electrically conducting glass, glass in electronic circuit components, and glass-reinforced plastics. Also covered are radiation conductivity emissivity, high energy radiation effects not yet completely treated in book form, stress testing and strength determination, background information on the manufacture of glass, and fibrous glass. Copies of the book are available from McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., at $10.

PUBLICATIONS OF THE AEC. Two publications of the U. S. Atomic Energy Commission (AEC) have been made available to the public: No. A-154, United States–Euratom Program; and No. A-162, a statement on peaceful uses of atomic energy by L. L. Strauss, then chairman of the AEC. Included in the former publication are Outline of Proposed United States–Euratom (European Atomic Energy Community) Program, International Agreement, and Memorandum of Understanding. The latter deals with research and other peaceful uses, industrial participation, and international co-operation, and contains several charts. Both releases may be obtained from the U. S. AEC, Washington 25, D. C.

1957 ASTM PROCEEDINGS, Volume 57. This volume, recording the technical accomplishments of the year, includes reports and papers together with discussions offered to the Society during the year and accepted for the Proceedings. Contained in the Proceedings are the Summaries of Proceedings of ASTM's 60th Annual Meeting and of the Philadelphia Spring Meeting, the annual President's address, the annual report of the Board of Directors, reports of technical committees, technical papers, and a listing of all symposiums and other special sessions published separately as Special Technical Publications as well as all papers published in the ASTM Bulletin. In addition, the Proceedings contains much discussion not previously published. Copies of the volume may be obtained, at $12, from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

SERIAL PUBLICATIONS OF THE SOVIET UNION, 1939-1957. A Bibliographic Checklist. This work attempts to include all government and nonofficial serial publications appearing in the Soviet Union in 1939 or later at regular or irregular intervals in all except oriental languages. Publications listed in such languages as Armenian, Georgian, Kirghiz, etc., are included only if they have a Russian-language title page and some contributions in Russian. The language of a serial other than Russian is specified in parentheses following the title. It should be noted that this checklist does not include serials published outside the Soviet Union, or any newspapers. Although only those serials published in 1939 or later are included, Library of Congress holdings of such serials are given in full. Information on serials received after the publication of this work may be obtained from subsequent issues of the Library's *Monthly Index of Russian Accessions*. Compiled by Rudolf Smits, Library of Congress, the publication, L.C. Card no. 58-60013, is available through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at $2.57. A subject guide is included.

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S. T. Maunder — Holyoke, Mass.
G. E. Maxim — Cleveland, Ohio
R. Mayer — Philadelphia, Pa.
H. R. Meahl — Schenectady, N. Y.
E. A. Miller — Cuba, N. Y.
H. R. Mimno — Cambridge, Mass.
E. E. Moyer — Cuba, N. Y.
N. E. Mullinex — Woodbine, Md.
L. L. Nagel — New York, N. Y.
S. R. Orem — Greenwich, Conn.
H. A. Owen, Jr. — Durham, N. C.
H. L. Palmer — Waynesboro, Va.
D. S. Peck — Allentown, Pa.
G. W. Penney — Pittsburgh, Pa.
R. B. Pherson — Sharon, Pa.
Leon Podolsky — North Adams, Mass.
A. J. Quigley — South Bend, Ind.
J. G. Reid, Jr. — Washington, D. C.
J. F. Reintjes — Cambridge, Mass.
D. K. Reynolds — Seattle, Wash.
J. R. Roeder — Baltimore, Md.
T. H. Rogers — Springdale, Conn.
J. D. Ryder — East Lansing, Mich.
A. Schmidt, Jr. — Lynchburg, Va.
D. T. Sigley — Los Angeles, Calif.
H. B. Slade — Passaic, N. J.
D. H. Smith — New York, N. Y.
S. W. Smith — Washington, D. C.
J. R. Somerville — Owensboro, Ky.
E. P. Spandau — Pacific Palisades, Calif.
C. F. Spitzer — Los Altos Hills, Calif.
J. R. Steen — Woburn, Mass.
H. C. Steiner — Schenectady, N. Y.
A. P. Stern — Syracuse, N. Y.
David Sussin — Madeiro, Ohio
Milton Tenzer — Fort Monmouth, N. J.
P. J. Toltesy — Verona, N. J.
G. R. Town — Washington, D. C.
D. E. Trucksess — New York, N. Y.
G. E. Walter — Fort Wayne, Ind.
R. C. Weyrick — Akron, Ohio
H. J. White — Bound Brook, N. J.
Harold Winograd — Milwaukee, Wis.
D. F. Winter — Kirkwood, Mo.
H. H. Wittenberg — Lancaster, Pa.
Victor Wouk — New York, N. Y.
A. M. Zarem — Pasadena, Calif.

Affiliates
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C. H. Clarridge — Rochester, N. Y.
F. M. Davis — Silver Spring, Md.
C. W. Kronmiller — Fort Wayne, Ind.
K. W. MacKenzie — Detroit, Mich.
H. J. McMains — St. Louis, Mo.
Tad Pelc — Long Beach, Calif.
F. W. Petit — Waterbury, Conn.
D. L. Waidelich — Columbia, Mo.

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R. C. Barker New Haven, Conn.
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R. M. Hubbard Seattle, Wash.
R. E. Hull Buffalo, N. Y.
W. C. Johnson Princeton, N. J.
David Katz Whipnany, N. J.
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Alfred Krausz Bedford, Ohio
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R. E. Morgan Schenectady, N. Y.
H. M. Ogle San Jose, Calif.
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W. F. Witzig Pittsburgh, Pa.
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Alfred Krancz Cleveland, Ohio
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Glen Ramsey North Chicago, Ill.
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T. S. Shilliday Columbus, Ohio
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R. A. York Clyde, N. Y.

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H. W. Welch, Jr. Phoenix, Ariz.

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R. S. Gardner, *Secretary* New York, N. Y.
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W. T. Rea Murray Hill, N. J.
Morris Rubinoff Philadelphia, Pa.
G. P. Stout Baltimore, Md.
J. G. Tuixol Brooklyn, N. Y.

Section Officers

Name	District	When Organized	Chairman	Secretary	Secretary's Address
Akron	11	Aug. 12, '20	E. L. Smith	E. F. Huston	Ohio Brass Co., P. O. Box 16, Barberton, Ohio
Alabama	13	May 22, '29	G. H. Hoffman	H. T. Uthlaut, Jr.	1515 Somerset Dr., Birmingham 9, Ala.
Arizona	8	Mar. 22, '41	L. A. Potter	S. M. Chalmers	4044 E. Whitton, Phoenix, Ariz.
Arkansas	7	Apr. 23, '47	Marion M. Riggs		
Arrowhead	5	Apr. 23, '47	Paul L. Bush	Parker Lowell	Minneapolis Power & Light Co., 30 W. Superior St., Duluth 2, Minn.
Baton Rouge	13	Feb. 3, '55	R. B. Holloway	J. L. Warmack	10010 Karen, Baton Rouge, La.
Beaumont	7	June 27, '45	Lloyd B. Cherry	G. J. Huckins	Westinghouse Electric Corp., 1014 Amer. Nat'l. Bank Bldg., Beaumont, Tex.
Boston	12	Feb. 13, '03	J. C. Hitt		
Canton	11	Nov. 4, '47	D. J. Harper	W. H. Sollie	2141 Halter Ave., N.W., Canton 8, Ohio
Central Illinois	5	June 28, '51	G. P. Wilson	J. O. Noel	Illinois Power Co., 134 E. Main St., Decatur, Ill.
Central Indiana	5	Jan. 12, '12	L. V. Leonard	R. H. Jordan	1446 E. Banta Road, Indianapolis, Ind.
Chicago	5	1893	J. A. Romano	F. A. Cox	Commonwealth Edison Co., Box 810—Rm. 1020, 72 W. Adams St., Chicago 90, Ill.
Cincinnati	11	June 30, '20	H. S. Progler III	Lester E. Bertke	Bertke Electric Co., 1030 W. 8th St., Cincinnati 3, Ohio
Cleveland	11	Sept. 27, '07	H. C. Martin	A. J. Hornfeck	Bailey Meter Co., 1051 Ivanhoe Rd., Cleveland 10, Ohio
Columbus	11	Mar. 17, '22	P. L. Gilmore	K. L. Livensparger	Ohio Bell Tel. Co., 42 E. Gay St., Columbus 15, Ohio

Connecticut	12	Apr. 16, '21	F. W. Engster	R. R. Shank	Dunham Laboratory of E. E., Yale University, New Haven, Conn.
Corpus Christi	7	Oct. 25, '51	R. H. Godeke	Jake M. Mabe, Jr.	1550 Lazy Lane, Corpus Christi, Tex.
Dayton	11	June 9, '43	B. J. Pleiss	Donald G. Tekamp	1854 Wesleyan Dr., Dayton, Ohio
Delaware Bay	2	June 1, '52	C. S. Collier	R. S. Forbes	107 Mulbery Road, Windy Hills, Newark, Del.
Denver	6	May 18, '15	Herschel P. Deming	Wayne L. Smith	Allis-Chalmers Mfg. Co., 655 Broadway Bldg., Denver 3, Colo.
East Tennessee	13	Sept. 2, '36	L. E. Marshall	H. C. Nichols	7308 W. Ridge Rd., Knoxville, Tenn.
El Paso	7	Mar. 7, '40	R. L. Combs	J. R. Hoffman	1105 Zuni Dr., El Paso, Tex.
Erie	1	Jan. 11, '18	E. H. Van Houten	J. T. Duane	950 W. Sixth St., Erie, Pa.
Fort Wayne	5	Aug. 14, '08	B. C. Biega		
Georgia	4	Jan. 14, '04	Wm. J. McKune	Dan C. Kyker	General Electric Co., 1860 Peachtree Road, Atlanta 3, Ga.
Hamilton	10	May 1, '53	A. G. Carter	J. G. Walach	Canadian Westinghouse Co., Ltd. Box 510, Hamilton, Ont., Canada
Hawaii	8	June 24, '54	J. F. Richardson, Jr.	Wilfred D. McKernon	4313 Keaka Drive, Honolulu 18, T.H.
Houston	7	Aug. 7, '28	V. P. Parr	J. B. Edmonds	The Okonite Co., 2116 Fannin, Houston 2, Tex.
Idaho	9	Apr. 5, '57	M. R. Harrell	Maynard M. Dye	1470 Scorpius Drive, Idaho Falls, Idaho
Illinois Valley	5	June 30, '45	C. E. Crawford	C. J. Nibbelin	R.R. 3 Cameron Lane, Peoria, Ill.
Iowa	6	June 29, '29	Otto Tennant		
Iowa-Illinois	5	June 24, '54	Carl W. Lauritzen	R. B. Miller	Iowa-Illinois Gas & Elec. Co., 206 E. 2nd., Davenport, Iowa
Ithaca	1	Oct. 15, '02	A. O. Kenyon	Simpson Linke	550 Warren Rd., Ithaca, N. Y.
Jacksonville	4	Jan. 28, '31	Leroy E. Elliott	James J. Zipperer	General Electric Supply Co., P. O. Box 56 Station G, Jacksonville 2, Fla.
Johnstown	2	Apr. 14, '55	R. D. Good	J. F. Worden	Bethlehem Steel Co., Johnstown, Pa.
Kansas City	7	Apr. 14, '16	H. R. Vaughan	D. C. Williams, Jr.	Southwestern Bell Tel. Co., 324 E. Eleventh St., Kansas City 6, Mo.
Lehigh Valley	2	Apr. 16, '21	I. M. McNair	J. K. McDonald	Pennsylvania Power & Light Co., 901 Hamilton St., Allentown, Pa.
Lima	11	June 24, '54	W. E. Wier	G. H. Sherer	Industrial Motor Engg. Dept., Westinghouse Elec. Corp., Lima, Ohio
Los Angeles	8	May 19, '08	E. D. Barcus	Robert Milmoe	Bechtel Corp., 4620 Seville Avenue, Vernon, Calif.
Louisville	13	Oct. 15, '26	J. D. Caudill	Richard Nalley	3231 Furman Blvd., Louisville 5, Ky.
Lynn	12	Aug. 22, '11	W. W. Work	J. C. Hammack, Jr.	Sylvania Elec. Prod. Inc., 75 Sylvan St., Danners, Mass
Madison	5	Jan. 8, '09			
Maine	12	June 30, '55	Lloyd W. Burr	G. F. Hart	Bangor Hydro-Electric Co., 33 State St., Bangor, Maine
Mansfield	11	Mar. 6, '39	J. G. Idle	Richard H. Risser	Ohio Brass Co., Mansfield, Ohio
Maryland	2	Dec. 16, '04	G. H. Carden	J. M. Kopper	Johns Hopkins University, 1315 St. Paul St., Baltimore 2, Md.
Memphis	13	May 22, '30	A. H. Beasley	J. F. Fletcher	Flinn, Fletcher, Humphrey, Inc. 606-07 Falls Bldg., Memphis, Tenn.
Mexico	7	June 29, '22	A. F. del Busto	G. Solis-Payan	Municipio Libre Num 89, Gray Anaya, Mexico 13 D. F., Mexico
Miami	4	Feb. 3, '49	V. B. Nolan	G. F. MacNichol	2715 Cordova St., Coral Gables, Fla.
Michigan	11	Jan. 13, '11	J. W. Eakins	B. H. Schneider	Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.
Milwaukee	5	Feb. 11, '10			
Minnesota	5	Apr. 7, '02	James Forchtner	C. A. Fagrelius	General Electric Co., 12 South 6th St., Minneapolis, Minn.
Mississippi	13	June 28, '51	R. E. Briggs	J. D. Phillips	Mississippi Power & Light Co., Jackson, Miss.
Mobile-Pensacola	13	Jan. 22, '53	E. E. Cobb	M. T. Borelli	306 Valencia, Gulf Breeze, Fla.
Montana	9	June 24, '31	M. O. Goldberg	H. C. Olsen	Mountain States Tel. & Tel. Co., 441 North Park, Helena, Mont.
Montreal	10	Apr. 16, '43	R. C. Short	P. E. Rose	Canadian General Electric Co., Ltd., 1010 Beaver Hall Hill, Montreal, Que., Canada
Nashville	13	June 28, '51	R. L. Hutto	A. T. Kanaday	1149 Ardee Avenue, Nashville 6, Tenn.
Nebraska	6	Jan. 21, '25	M. I. Risley	P. H. Henson	Lincoln Tel. & Tel. Co., 1342 M St., Lincoln, Nebr
New Hampshire	12	Sept. 3, '53	J. H. Spencer	R. A. Nichols	Public Service Co. of N. H., 1087 Elm St., Manchester, N. H.
New Orleans	13	Dec. 8, '33	S. G. Dinkel	S. Cambias, Jr.	1606 Charlton Dr., New Orleans, La.
New York	3	Dec. 10, '19	W. T. Rea	R. M. Franklin	74 Searingtown Rd., Roslyn, N. Y.
Niagara Frontier	1	Feb. 10, '25	M. L. Rowley	E. V. Ellett	Westinghouse Elec. Corp., 814 Ellicott Sq. Bldg., Buffalo 3, N. Y.
Niagara International	10	Aug. 5, '48			
North Carolina	4	Mar. 21, '29	W. J. Wortman	M. T. Hatley, Jr.	Duke Power Co., P. O. Box 2178, Charlotte 1, N. C.
Northeastern Michigan	11	Feb. 2, '50	R. C. Youngdahl	R. J. Johnston, Jr.	3602 Keyes St., Flint, Mich.
Northeastern Wisconsin	5	Feb. 4, '58	W. L. Sykes	C. A. Lins	Westinghouse Elec. Corp., 339 W. College Ave., Appleton, Wis.
Northern New Mexico	7	Jan. 25, '51	J. A. Barber	R. G. Hamilton	419 Hermoso Dr., N.E., Albuquerque, N. Mex.
North Texas	7	May 18, '28	D. N. Chadwick	R. T. Martin	4154 Lively Lane, Dallas, Tex.
Oak Ridge	13	Feb. 1950	A. S. Willumsen	W. D. Plengey	1301 Dogwood Dr., Route 4, Kingston, Tenn.
Ohio Valley	11	June 28, '51	R. D. Crippen	I H. Reeves	3035 Wallace Circle, Huntington, W. Va.
Oklahoma City	7	Feb. 16, '22	Sim Wright	H. L. Tredennick	General Electric Co., 1106 Cravens Bldg., Oklahoma City 2, Okla.
Ottawa	10	June 25, '49	E. W. Humphrys	N. L. Kusters	817 Eastbourne Ave., Ottawa 2, Ont., Canada
Panhandle Plains	7	June 12, '47	J. R. Ragland	Fray Smith	3010 25th St., Lubbock, Tex.
Philadelphia	2	Feb. 18, '03	G. B. Schleicher	H. L. Halberstadt	1105 Old Gulph Rd., Rosemont, Pa.
Pittsburgh	2	Oct. 3, '02	W. R. Harris	W. H. Mutschler, Jr.	Allis-Chalmers Mfg. Co., Columbus & Preble Aves., Pittsburgh 12, Pa.
Pittsfield	12	Mar. 25, '04	W. W. Green	W. F. Dripps	328 Lebanon Ave., Pittsfield, Mass.
Portland	9	May 18, '09	L. H. Wolgast	Cecil L. Brown	Pacific Pr. & Lt. Co., 920 S.W. Sixth, Portland 4, Oreg
Providence	12	Mar. 12, '20	R. H. Taylor	A. L. Marshall	21 Woburn Rd. Rumford 16, R. I.
Richland	9	Apr. 23, '48	I. M. Garcia	J. G. Bennett	1114 Cedar, Richland, Wash.
Ridgway	2	June 26, '52	J. S. Askey	L. G. Harper	617 Center St., St. Marys, Pa.
Rochester	1	Oct. 9, '14	S. P. Bartles	H. L. Foote	Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.

Rock River Valley	5	Apr. 23, '47	N. G. Alvis	M. H. Shatswell, Jr.	Barber Colman Co., Rockford, Ill.
Sacramento	8	June 15, '50	R. N. Keen	V. R. Boulton	4141 Winding Creek Rd., Sacramento 21, Calif.
St. Louis	7	Jan. 14, '03	F. R. Summers	C. E. Howe	4917 Hooke, St. Louis 15, Mo.
St. Maurice Valley	10	June 24, '54			
San Diego	8	Jan. 18, '39	M. R. Marston, Jr.	L. R. Knerr	316 Bandera St., La Jolla, Calif.
San Francisco	8	Dec. 23, '04	M. G. Lewis	H. N. Skow	Westinghouse Elec. Corp., 410 Bush St., San Francisco, Calif.
Savannah	4	Oct. 14, '54	F. B. Hickman	P. B. Sowell	General Electric Co., 40 E. Bay Street, Savannah, Ga.
Schenectady	1	Jan. 26, '03	L. K. Kirchmayer	J. J. W. Brown	General Electric Co., 1 River Road, Schenectady, N. Y.
Seattle	9	Jan. 19, '04	A. W. Kessler	H. M. Swarm	University of Washington, Dept. of E.E., Seattle 5, Wash.
Sharon	2	Dec. 11, '25	E. A. Winslow	R. L. Custard	R.D. 1 Box 426, Vienna, Ohio
Shreveport	7	June 12, '47	A. M. Randolph	P. L. Gunn	Southwestern Gas & Electric Co., 428 Travis St., Shreveport, La.
South Bend	5	Feb. 26, '41	Wayne Frost		
South Carolina	4	Mar. 2, '40	J. G. Mann	J. S. Meyers	705 Abelia Rd., Columbia 5, S. C.
South Texas	7	May 23, '30	F. O. December	W. F. Pavette, Jr.	Rt. 10, Box 77P, San Antonio, Tex.
Spokane	9	Feb. 14, '13	L. C. Ford	J. F. Evrich	E. 2732 Marshall Ave., Spokane, Wash.
Springfield	12	June 29, '22	C. G. Schmidt	R. D. Wood	73 Dewitt St., Springfield, Mass.
Susquehanna	2	June 18, '53	D. B. Chubb	J. L. Mumma	Pennsylvania Power & Light Co., P. O. Box 435, Harrisburg, Pa.
Syracuse	1	Aug. 12, '20	J. W. Munnis	Robert Nevin	4182 Franklin St., Fayetteville, Ky.
Tampa	4	Feb. 1, '52	E. W. Morris		
Toledo	11	June 3, '07	W. H. Schwalbert	P. E. Thornberry	Westinghouse Electric Corp., 245 Summit Ave., Toledo 4, Ohio
Toronto	10	Sept. 30, '03	R. B. Steele	J. M. Ham	University of Toronto, Dept. of E.E., Toronto, Ont., Canada
Tulsa	7	Oct. 1, '37		J. T. Woodson	924 So. Oswego, Tulsa, Okla.
Utah	9	Mar. 9, '17	E. W. Hendron	J. D. Stephens	1020 Douglas, Salt Lake City, Utah
Vancouver	9	Aug. 22, '11	M. I. G. Bradwell	M. E. Green	Northwest Tel. Co., 2226 W. 10th Ave., Vancouver 9, B.C., Canada
Victoria	9	Oct. 5, '56	Guy Barclay	C. Y. Spratt	Spratt & Assoc., Consulting Engrs. 1216 Broad St., Victoria, B.C., Canada
Virginia	4	May 19, '22	M. S. Spicer	A. S. Hadfield	8502 Rivermont Dr., Richmond 26, Va.
Virginia Mountain	4	June 23, '49	E. C. Rankin	J. W. Kepner	3939 Richland Ave., Roanoke 12, Va.
Washington	2	Apr. 9, '03	J. J. A. Jessel	B. F. Slingluff	Potomac Elec. Pr. Co., 5900 Forest Rd., Cheverly, Md.
West Michigan	11	June 24, '54	G. F. Raven	Stanley Van Antwerp	Route 3, Hudsonville, Mich.
West Virginia	11	Apr. 9, '40	E. C. Krukiel	B. W. Whittington	Route 5—Box 555, Charleston, W. Va.
Wichita	7	Sept. 16, '37			
Worcester	12	Feb. 18, '20	C. J. Lake	W. J. Creighton	General Elec. Co., 288 Grove St., Worcester 5, Mass.

Total Sections.....112

Subsection Officers

Name (Parent Section Shown in Parentheses)	District	Chairman	Secretary	Secretary's Address
Adirondack (Schenectady)	1	G. L. Viles	G. R. Menkart	Bldg. 1-4, General Electric Co., Hudson Falls, N. Y.
Atlantic City Division (Philadelphia)	2	E. J. Brown	R. G. Michael, Jr.	Atlantic City Electric Co., 1600 Pacific Ave., Atlantic City, N. J.
Billings (Montana)	9	D. M. Severtson	C. W. Lee	1017-25th St. West, Billings, Mont.
Binghamton Area (Ithaca)	1	L. L. Brandow	R. D. Batley	Westinghouse Electric Corp., 419 Grand Ave., Johnson City, N. J.
Black Hills (Denver)	6	W. A. Hixson	C. K. Hale	1121 North Seventh St., Rapid City, S. Dak.
Blue Ridge (Virginia)	4	R. S. Stewart	D. B. Schneider	Waynesboro-General Elec. Co., 408 Bader St., Staunton, Va.
Boulder City (Los Angeles)	8	L. F. Hartmann	O. L. Craig	536 Birch St. Boulder City, Nev.
Butte (Montana)	9	R. C. Nealey	W. D. Turner	Northwest States Supply Co., Box 368, Butte, Mont.
Cedar Valley (Iowa)	6			
Central Savannah River (South Carolina)	4	V. D. Snow	E. C. Speed	411 Metz Dr., No. Augusta, S. C.
Central Texas (North Texas)	7	M. S. Sturdivant	R. J. Sayger	Brazos Elec. Pr. Coop. Inc., 2404-12 La Salle Ave., Waco, Tex.
Centre County (Pittsburgh)	2	V. E. Harris	G. A. Etzweiler	1114 S. Garner St., State College, Pa.
Charleston (South Carolina)	4	E. E. Moore, Jr.	L. B. Paulsen	W. Virginia Pulp & Paper Co. Charleston, S. C.
Charlotte (North Carolina)	4	N. M. Fowler	H. I. Whitehead, Jr.	Westinghouse Elec. Corp., P. O. Box 1399, Charlotte, N. C.
Chillicothe (Columbus)	11	A. F. Wilson	Les Hurst	324 Wendy La., Waverly 3, Ohio
Columbia (South Carolina)	4	R. G. Fellows	B. L. Lowman	3212 Park St., Columbia 2, S. C.
Eastern Division (St. Louis)	7	J. H. Lamming	E. R. Christman	7122 Valbrook Lane, Affton 23, Mo.
Eastern North Carolina (North Carolina)	4	E. J. Moore	T. D. Barnes	Westinghouse Elec. Corp., Meter Div., P. O. Box 9533, Raleigh, N. C.
Eastern Shore (Maryland)	2			
Eugene (Portland)	9	D. E. Heym	R. R. Michael	Oregon State College, Dept. of E.E., Corvallis, Oreg.
Fort Worth (North Texas)	7	J. D. Padgett, Jr.	J. S. Gallagher	3925 W. 5th St., Fort Worth, Tex.
Freeport (Houston)	7	F. M. Leever	C. E. Neill	309 So. Farrer, Angleton, Tex.
Fresno Division (San Francisco)	8	D. M. Jensen	J. G. Floyd	3127 Alta Ave., Fresno 2, Calif.
Guelph (Hamilton)	10	L. J. MacKinnon	A. G. Stacey	Bd. of Lt. & Heat Comm., 25 Wyndham St. S., Guelph, Ont., Canada
Hampton Roads (Virginia)	4	D. M. Crabtree	John Bowman	915 W. 21st Street, Norfolk 10, Va.
Helena (Montana)	9	J. H. Bielenburg	W. C. Klocker	Montana Pr. Co., Helena, Mont.
Hudson Valley Division (New York)	3			

Huntsville (East Tennessee)	13	R. J. Boehme	J. W. Moody	3414 Wildwood Drive, Huntsville, Ala.
Jackson (Memphis)	13	A. P. Brazleton	J. F. Phillips	Administrative Asst. TVA, P. O. Box 911, Jackson, Tenn.
Lake Charles (Beaumont)	7			
Lexington (Louisville)	13	H. D. Fox	B. W. Gentry	231 Koster, Lexington, Ky.
London (Hamilton)	10			
Los Alamos-Santa Fe (Northern New Mexico)	7	L. E. Lanhan	R. O. Velasco	572 Kiva St., Los Alamos, N. Mex.
Marion (Fort Wayne)	5			
Medford (Portland)	9	C. R. Rolls	W. H. Fisher	32 Black Oak Dr., Medford, Oreg.
Merrimack Valley (Lynn)	12	C. E. Chapman, Jr.	R. L. Case	Bell Tel. Labs. Inc., Merrimack Valley Lab., So. Union St., Lawrence, Mass.
Mid-State (North Carolina)	4	M. S. Gantt	E. D. Fox	Western Elec. Co., Winston-Salem, N. C.
Monroe (Shreveport)	7	J. R. McKinley	J. H. Hebert	1001 St. John, Monroe, La.
Monterey (Mexico)	7			
Montgomery (Alabama)	13	C. S. Weiss	J. E. Danner	Alabama Power Co., 123 Dexter Ave., Montgomery, Ala.
Muscle Shoals (East Tennessee)	13	A. E. Wolfe	R. L. Lee	128 E. Lee Ave., Florence, Ala.
New Jersey Division (New York)	3	M. T. Whiting	E. C. Yurgelun	79 Norwood Ave., Glen Rock, N. J.
New London (Connecticut)	12			
Northwest Arkansas (Arkansas)	7			
Northwest Iowa (Iowa)	6	C. N. Marple	R. W Johnston	Iowa Public Service Co., Orpheum Elec. Bldg., Sioux City, Iowa
Paducah (Louisville)	13			
Palm Beach (Miami)	4			
Panama City (Mobile-Pensacola)	13	J. R. Youd	R. E. Lealman	1611 DeWitt, Panama City, Fla.
Piedmont (South Carolina)	4	T. A. Palmer	Leslie Reynolds	44 Crestfield Rd., Greenville, S. C.
Quebec (Montreal)	10			
Racine-Kenosha (Milwaukee)	5			
Red River Valley Division (Minnesota)	5	C. J. Thomforde	V. A. Matheson	325 Third St., North, Breckenridge, Minn.
Reno (San Francisco)	8	J. R. Rice	L. W. Hubert	Bell Tel. Co. of Nev., Reno, Nev.
Richmond (Virginia)	4	H. V. Horner	L. F. Paret	4000 W Broad St., Richmond 21, Va.
Riverside-San Bernardino (Los Angeles)	8	C. L. Westmann	E. B. Heath	San Bernardino Valley Col., San Bernardino, Calif
Rome (Georgia)	4			
St. Lawrence International (Syracuse)	1			
Santa Clara Valley (San Francisco)	8	J. M. Shulman	H. M. McLaughling	Lockheed Missiles, System Div., Palo Alto, Calif.
Scioto Valley (Ohio Valley)	11	J. M. Duncan	W. G. Russell	1926 Sunrise Ave., Portsmouth, Ohio
Shasta (San Francisco)	8	F. L. Gobel	W. R. Hampton	Pacific Gas & Elec. Co., Storrie, Calif.
Southern Idaho (Idaho)	9	W. B. Mitchel	J. G. Hannum	Idaho Power Co., Box 770, Boise, Idaho
Tacoma (Seattle)	9	C. K. Meek	W. A. Smith	425 Buena Vista, Tacoma 66, Wash.
Tullahoma (East Tennessee)	13	J. J. Komisky	P. L. Clemens	504 Cumberland Ave., Tullahoma, Tenn.
Upper East Tennessee (East Tennessee)	13	R. L. Taylor	W. D. Dishner	Johnson City Power Broad, 100 North Roan St., Johnson City, Tenn.
Upper Monongehela Valley (Pittsburgh)	2			
Vermont (Pittsfield)	12	R. O. King	A. R. Eckels	Dept. of Elec. Eng., University of Vermont, Burlington, Vt.
Victoria-Port Lavaca (Corpus Christi)	7	T. P. Holmes	J. H. Wieting	3403 Morningside Dr., Victoria, Tex.
Wenatchee (Spokane)	9	H. M. Schoffen	J. C. Barber	Box 4-190F Route 4, Wenatchee, Wash.
West Central Texas Division (North Texas)	7			
Western North Carolina (North Carolina)	4			
Zanesville (Columbus Section)	11	Hubert Reber	P. F. Gramlich	583 Dryden Road, Zanesville, Ohio
Total Subsections	71			

Student Branch Officers

Name and Location	Counselor District	(Member of Faculty)
*Akron, University of, Akron, Ohio	11	Kenneth F. Sibila
Alabama Polytechnic Institute, Auburn, Ala.	13	A. T. Sprague, Jr.
*Alabama, University of, University, Ala.	13	W. F. Gray
Alaska, University of, College, Alaska	9	Robert P. Merritt
*Alberta, University of, Edmonton, Alta, Canada	10	R. E. Phillips
†Arizona State College, Tempe, Ariz.	8	Russell L. Riese
*Arizona, University of, Tucson, Ariz.	8	James L. Knickerbocker
*Arkansas, University of, Fayatteville, Ark.	7	Bryan Webb, Jr.
†Bradford Durfee College of Technology, Fall River, Mass.	12	Bertram B. Hardy
†Bradley University, Peoria, Ill.	5	Philip Weinberg
*British Columbia, University of, Vancouver, B.C., Canada	9	L. R. Kersey
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Day)	3	C. W. Lawrence
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Evening)	3	Robert E. Bauer
*Brown University, Providence, R. I.	12	
*Bucknell University, Lewisburg, Pa.	2	Honer E. Webb
†Buffalo, University of, Buffalo, N. Y.	1	
*California Institute of Technology, Pasadena, Calif.	8	G. D. McCann
†California State Polytechnic College, San Luis Obispo, Calif.	8	Warren R. Anderson
*California, University of, Berkeley, Calif.	8	Henry C. Bourne, Jr.
*Carnegie Institute of Technology, Pittsburgh, Pa.	2	Arthur G. Milnes
*Case Institute of Technology, Cleveland, Ohio	11	R. D. Chenoweth
Catholic University of America, Washington, D C.	2	J. C. Michalowicz
†Christian Brothers College, Memphis, Tenn.	13	Lawrence Philip
*Cincinnati, University of, Cincinnati, Ohio	11	W. H. Middendorf
*Clarkson College of Technology, Potsdam, N. Y.	1	
*Clemson A&M College, Clemson, S. C.	4	H. V. Poe
*Colorado State University, For Collins, Colo.	6	C. H. Chinberg
*Colorado, University of, Boulder, Colo.	6	G. E. Giess, Jr.
*Columbia University, New York, N. Y.	3	P. Mauzey
*Connecticut, University of, Storrs, Conn.	3	Harold M. Lucal
*Cooper Union, New York, N. Y.	3	Sidney Epstein
*Cornell University, Ithaca, N. Y.	1	
*Dayton, University of, Dayton, Ohio	11	James N. Yakura
*Delaware, University of, Newark, Del.	2	H. Hellerman

*Denver, University of, Denver, Colo.	6	
*Detroit, University of, Detroit, Mich.	11	William Clark
*Drexel Institute of Technology, Philadelphia, Pa.	2	F. C. Powell
Duke University, Durham, N. C.	4	J. L. Artley
Fenn College, Cleveland, Ohio	11	R. W. Schindler
*Florida, University of, Gainesville, Fla.	4	Tewes Kundel
†Gannon College, Erie, Pa.	1	
*George Washington University, Washington, D. C.	2	Norman B. Ames
Georgia Institute of Technology, Atlanta, Ga.	4	E. R. Weston
†Houston, University of, Houston, Tex.	7	W. T. Kittinger
*Howard University, Washington, D. C.	2	E. R. Welch
Idaho, Institute of, Moscow, Idaho	9	W. R. Parish
Illinois Institute of Technology, Chicago, Ill.	5	B. A. Fisher
*Illinois, Institute of, Urbana, Ill.	5	J. E. Williams
Chicago Division, Chicago, Ill.	5	A. J. Klapperich
*Iowa State College, Ames, Iowa	6	W. L. Hughes
Iowa, University of, Iowa City, Iowa	5	E. B. Kurtz
*Johns Hopkins University, Baltimore, Md	2	Thorstein Larsen
*Kansas State College, Manhattan, Kans.	7	Melvin C. Cottom
*Kansas, University of, Lawrence, Kans.	7	Louis Breyfogle
Kentucky, University of, Lexington, Ky.	13	Lyle N. Back
*Lafayette College, Easton, Pa.	2	F. W. Smith
†Lamar State College of Technology, Beaumont, Tex.	7	Lyle E. Bohrer
Laval University, Quebec, Que., Canada	10	Maurice Boisvert
*Lehigh University, Bethlehem, Pa.	2	Joseph Teno
*Louisiana Polytechnic Institute, Ruston, La.	7	M. R. Johnson
*Louisiana State University, Baton Rouge, La.	13	M. B. Reed
*Louisville, University of, Louisville, Ky.	13	Leo B. Jenkins
*Maine, University of, Orono, Maine	12	Kenneth L. Parsons
*Manhattan College, New York, N. Y.	3	Robert T. Weil, Jr.
*Marquette University, Milwaukee, Wis.	5	Stanley Krupnik
*Maryland, University of, College Park, Md.	2	L. J. Hodgins
*Massachusetts Institute of Technology, Cambridge, Mass.	12	L. A. Gould
*Massachusetts, University of, Amherst, Mass.	12	F. H. Edwards
†Merrimack College, N. Andover, Mass.	12	J. F. Sullivan
†Miami, University of, Coral Gables, Fla.	4	Frank B. Lucas
*Michigan College of Mining and Technology, Houghton, Mich.	5	G. W. Swenson
*Michigan State University, East Lansing, Mich.	11	Ira B. Baccuss
*Michigan, University of, Ann Arbor, Mich.	11	J. G. Tarboux
Milwaukee School of Engineering, Milwaukee, Wis.	5	R. J. Ungrodt
*Minnesota, University of, Minneapolis, Minn.	5	P. A. Cartwright
Mississippi State College, State College, Miss.	13	Donald F. Fitzgerald
*Missouri School of Mines and Metallurgy, Rolla, Mo.	7	James H. Johnson
*Missouri, University of, Columbia, Mo.	7	J. C. Hogan
*Montana State College, Bozeman, Mont.	9	R. F. Durnford
*Nebraska, University of, Lincoln, Nebr.	6	David W. Olive
*Nevada, University of Reno, Nev.	8	Eugene M. Menke
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†New Bedford Institute of Technology, New Bedford, Mass.	12	J. F. Wareing
*New Hampshire, University of, Durham, N. H.	12	Donald W. Melvin
*New Mexico College of A&M Arts, State College, N. Mex.	7	C. D. Crosno
*New Mexico, University of, Albuquerque. N. Mex.	7	Arthur W. Melloh
*New York, College of the City of, New York, N. Y.	3	W. T. Hunt
*New York University, New York, N. Y. (Day)	3	Arvin Grable
*New York University, New York, N. Y. (Evening)	3	L. J. Hollander
*North Carolina State College, Raleigh, N. C.	4	Edwin W. Winkler
*North Dakota State College, Fargo, N. Dak.	5	E. M. Anderson
*North Dakota, University of, Grand Forks, N. Dak.	5	John D. Dixon
*Northeastern University, Boston, Mass.	12	
*Northwestern University, Evanston, Ill.	5	Richard W. Jones
*Norwich University, Northfield, Vt.	12	Philip M. Seal
*Notre Dame, University of, Notre Dame, Ind.	5	L. F. Stauder
*Ohio Northern University, Ada, Ohio	11	Carroll R. Alden
*Ohio State University, Columbus, Ohio	11	F. C. Weimer
*Ohio University, Athens, Ohio	11	Gustavus Smith
*Oklahoma State University, Stillwater, Okla.	7	T. B. Thompson
*Oklahoma, University of, Norman, Okla.	7	J. D. Palmer
Oregon State College, Corvallis, Oreg.	9	Solon A. Stone
*Pennsylvania State University, University, Park, Pa.	2	R. E. Armington
*Pennsylvania, University of, Philadelphia, Pa.	2	Raymond Berkowitz
Pittsburgh, University, of, Pittsburgh, Pa.	2	R. C. Gorham
*Pratt Institute, Brooklyn, N. Y.	3	Maurice L. Hashmall
*Princeton University, Princeton N. Y.	2	H. M. Chandler, Jr.
Puerto Rico, University of, Mayaguez, P. R.	3	L. R. Culver
*Purdue University, Lafayette, Ind.	5	S. Freeman, Jr.
*Rensselaer Polytechnic Institute, Troy, N. Y.	1	
*Rhode Island, University of, Kingston, R. I.	12	J. F. Grove
*Rice Institute, Houston, Tex.	7	Paul E. Pfeiffer
*Rose Polytechnic Institute, Terre Haute, Ind.	5	R. D. Strum
*Rutgers University, New Brunswick, N. J.	3	J. R. Rankin, Jr.
Saint Louis University, St. Louis, Mo.	7	William M. McCabe
*University of Santa Clara, Santa Clara, Calif.	8	J. A. Peterson
†Seattle University, Seattle, Wash.	9	D. K. Reynolds
*South Carolina, University of, Columbia, S. C.	4	
South Dakota School of Mines and Technology, Rapid City, S. Dak.	6	William A. Hixson
*South Dakota State College, Brookings, S. Dak.	6	Maoling Liu
*Southern California, University of, Los Angeles, Calif.	8	Rodney C. Lewis
*Southern Methodist University, Dallas, Tex.	7	F. W. Tatum
Southwestern Louisiana Institute, Lafayette, La.	13	A. W. Grove
*Stanford University, Stanford, Calif.	8	Rudolf Panholzer
*Stevens Institute of Technology, Hoboken, N. J.	3	H. W. Phair
*Swarthmore College, Swarthmore, Pa.	2	Carl Barus
*Syracuse University, Syracuse, N. Y.	1	
†Tennessee Polytechnic Institute, Cookeville, Tenn.	13	Albert L. Duke
Tennessee, University of, Knoxville, Tenn.	13	
*Texas, A&M College of, College Station, Tex.	7	Willard P. Worley
†Texas College of Arts & Industries, Kingsville, Tex.	7	Emerson Korges
*Texas Technological College, Lubbock, Tex.	7	T. B. Stenis
*Texas, University of, Austin, Tex.	7	R. R. Krezdorn
Texas Western College, El Paso, Tex.	7	Manual Gomez, Jr.
*Toledo, University of, Toledo, Ohio	11	D. J. Ewing
*Toronto, University of, Toronto, Ont., Canada	10	J. E. Reid
*Tufts College, Medford, Mass.	12	David E. Higginbotham
*Tulane University, New Orleans, La.	13	G. W. Webb
*Union College, Schenectady, N. Y.	1	
United States Naval Academy, Annapolis, Md.	2	
United States Naval Post Graduate School, Monterey, Calif.	8	Orval H. Polk
Utah State University, Logan, Utah	9	Bruce O. Watkins
*Utah, University of, Salt Lake City, Utah	9	R. E. Stephenson
Vanderbilt University, Nashville, Tenn.	13	James R. Wilson, Jr.
*Vermont, University of, Burlington, Vt.	12	Charles W. Hoilman
*Villanova College, Villanova, Pa.	2	
Virginia Military Institute, Lexington Va.	4	Lee L. Nichols, Jr.
*Virginia Polytechnic Institute, Blacksburg	4	C. Lee
*Virginia University of, Charlottesville, Va.	4	J. M. Roberts
*Washington, State College of, Pullman, Wash.	9	David A. Seamans
*Washington, University of, Seattle, Wash.	9	F. D. Robbins
*Washington University, St. Louis, Mo.	7	Marvin J. Fisher
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†West Virginia Institute of Technology, Montgomery, W. Va.	11	Paul M. Gray
*West Virginia University, Morgantown, Va.	2	E. C. Dubbe
†Wichita, University of, Wichita, Kans.	7	A. T. Murphy
*Wisconsin, University of, Madison, Wis.	5	W. B. Swift
*Worcester Polytechnic Institute, Worcester, Mass.	12	W. R. Grogan
*Wyoming, University of, Laramie, Wyo.	6	R. K. Beach
*Yale University, New Haven, Conn.	12	J. C. May
Youngstown College, Youngstown, Ohio	2	E. A. Klingshirn

*Joint AIEE-IRE Branches	114
†Affiliate Branches	17
Total Branches	160

District Officers

District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities	District Representative of Membership Committee	District Representative of Sections Committee	District Representative of Technical Operations Department
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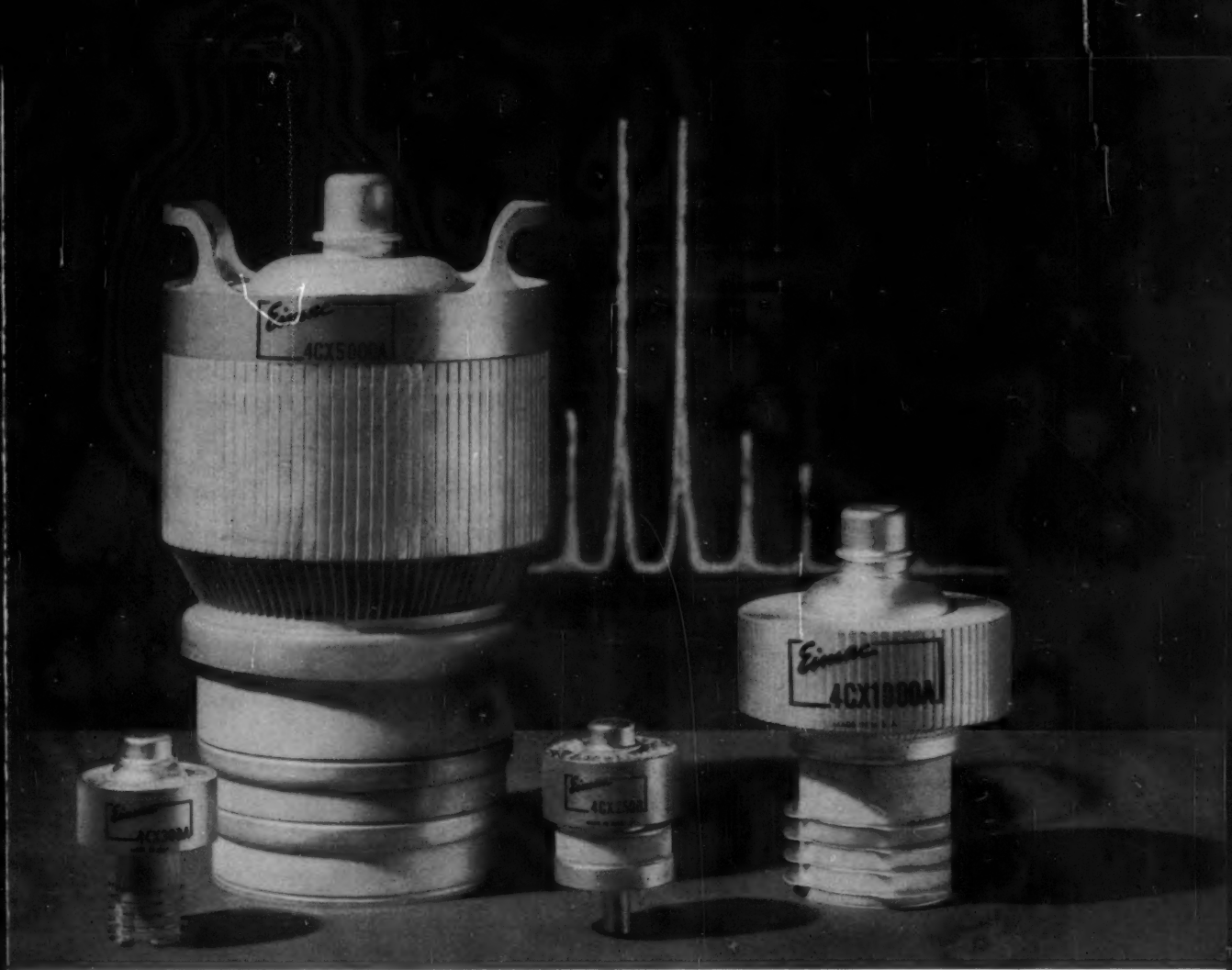
2 Middle Eastern .	B. R. Teare, Jr., Dept. of Elec. Engg., Carnegie Institute of Technology, Pittsburgh, Pa.	E. R. Schatz, College of Engg., Carnegie Institute of Technology, Pittsburgh, Pa.	Carl Barus, Dept. of Elec. Engg., Swarthmore College, Swarthmore, Pa.	A. H. Sellers, Philadelphia Electric Co., 900 Sansom St., Philadelphia, Pa.	R. N. Wagner, Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh, Pa.	S. R. Warren, Jr., Town Bldg., Room 109, 220 South 33rd St., Philadelphia 4, Pa.
3 Metropolitan New York ...	J. R. Kerner, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.	R. T. Weil, Jr., Manhattan College, 4313 Manhattan Parkway at 242nd St., New York, N. Y.	J. R. Rankin, College of Engineering, Rutgers University, New Brunswick, N. J.	W. G. Cheney, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.	W. A. Clark, American Tel. & Tel. Co., 195 Broadway, New York 7, N. Y	C. I. Hubert, U. S. Merchant Marine Academy, Kings Point, L. I., N. Y.
4 South East	H. W. Oetinger, Duke Power Company, Charlotte 1, N. C.	B. V. Martin, Westinghouse Electric Corp., Box 1399, Charlotte 1, N. C.	E. R. Weston, School of Engg., Georgia Institute of Technology, Atlanta, Ga.	J. W. Davis, Southern Bell Tel. & Tel. Co., Room 540, Hurt Bldg., P.O. Box 2211, Atlanta 1, Ga.	R. H. Stevens, Florida Power & Light Co., Miami, Fla.	W. P. Molette, General Electric Co., 700 E. Franklin St., Richmond 17, Va.
5 Great Lakes	R. B. Gear, Commonwealth Edison Co., 72 West Adams St., Chicago 90, Ill.	F. W. Bush, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.	G. W. Swenson, Dept. of Elec. Engg., Michigan College of Mining and Technology, Houghton, Mich.	D. F. Hayworth, Western Electric Co., Inc., Hawthorne Station, Chicago 23, Ill.	H. C. Brem, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.	G. L. Welch, Westinghouse Electric Corp., Merchandise Mart Plaza, Chicago 54, Ill.
6 North Central ..	A. G. Johnson, Omaha Public Power District, Electric Bldg., Omaha, Nebr.	C. S. Roadhouse, Omaha Public Power District, 17th & Harney, Omaha, Nebr.	R. K. Beach, Dept. of Elec. Engg., University of Wyoming, Laramie, Wyo.	J. O. Nelson, Omaha District, U.S. Corps of Engineers, 1709 Jackson, Omaha, Nebr.	C. W. Keller, General Electric Co., 650 17th St., Denver, Colo.	J. L. McKinley, 660 Oneida St., Denver 20, Colo.
7 South West	I. T. Monseth, Westinghouse Electric Corp., 411 N. 7th St., St. Louis 1, Mo.	O. T. Farry, Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.	T. B. Stenis, Dept. of Elec. Engg., Texas Technological College, Lubbock, Texas	W. C. Fowler, 2424 Colonial Parkway, Fort Worth 9, Texas	W. E. Silvus, General Electric Co., Box 1703, Houston 1, Texas	P. M. Honnell, Dept. of Elec. Engg., Washington University, St. Louis 5, Mo.
8 Pacific	O. A. Gustafson, General Electric Co., 235 Montgomery St., San Francisco, Calif.	C. E. Baugh, Pacific Gas & Electric Co., 245 Market St., San Francisco 6, Calif.	J. L. Knickerbocker, Dept. of Elec. Engg., University of Arizona, Tucson, Ariz.	R. E. Grady, 353 Sacramento Street, San Francisco 11, Calif.	Whitman Ridgway, General Electric Co., 235 Montgomery St., San Francisco, Calif.	C. A. Wells, Pacific Tel. & Tel. Co., 740 South Olive St., Los Angeles 55, Calif.
9 North West	J. M. Nelson, Lighting Dept., City of Seattle, 1015 3rd Ave., Seattle 4, Wash.	A. W. Moody, General Electric Co., P. O. Box 1858, Seattle 11, Wash.	W. R. Parish, Dept. of Elec. Engg., University of Idaho, Moscow, Idaho	R. D. Brown, Allis-Chalmers Mfg. Co., 602 Old National Bank Bldg., Spokane, Wash.	M. M. Ewell, Westinghouse Electric Corp., 309 S.W. 6th Ave., Portland, Oreg.	W. J. Dowis, General Electric Co., Rishland, Wash.
10 Canada	G. F. Tracy, Electrical Bldg., University of Toronto, Toronto, Ont., Canada	D. N. Culver, Bell Telephone Co., 393 University Ave., Toronto, Ont., Canada	Maurice Boisvert, Dept. of Elec. Engg., Laval University, Quebec, Canada	C. R. Thornton, Canadian Line Materials, 168 Charlotte St., Ottawa, Ont., Canada	T. C. D. Churchill, Bell Telephone Co. of Canada, Ltd., 393 University Ave., Toronto, Ont., Canada	Felix L. French, Aluminum Co. of Canada, Ltd., 1700 Sun Life Bldg., Montreal, Que., Canada
11 East Central	W. H. Chase, Ohio Bell Telephone Co., 750 Huron Road, Cleveland 15, Ohio	C. V. Carlson, Ohio Bell Telephone Co., 750 Huron Road, Cleveland 15, Ohio	R. W. Schindler, Dept. of Elec. Engg., Fenn College, Cleveland, Ohio	O. C. Zingrebe, O. C. Zingrebe Co., 5700 Ridge Road, Cleveland, Ohio	N. L. Danforth, Jr., Allis-Chalmers Mfg. Co., 1703 Toledo Trust Bldg., Toledo 4, Ohio	L. M. Moore, Columbus & Southern Ohio Electric Co., 215 N. Front Street, Columbus 15, Ohio
12 North Eastern ..	S. M. Osthagen, Allis-Chalmers Mfg. Co. 240 Olney St., Providence, R. I.	F. S. Bacon, Jr., P.O. Box 58, Winchester, Mass.	P. M. Seal, Dept. of Elec. Engg., Norwich University, Northfield, Vt.	J. M. Lydon, Boston Edison Co., 39 Boylston St., Boston, Mass.	E. E. Linden, Narragansett Electric Co., Box 1686, Providence, R. I.	W. A. McMorris, General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.
13 South Central ...	C. P. Knost, Moloney Electric Co., 4018 Thalia St., New Orleans 25, La.	M. L. Hurstell, New Orleans Public Service, Inc., 317 Baronne St., New Orleans, La.	W. F. Gray, Dept. of Elec. Engg., University of Alabama, University, Ala.	Walter Criley, Vanderbilt University, Box 1588, Station B, Nashville 4, Tenn.	W. C. Burnett, Southern Bell Tel. & Tel. Co., 1706 2nd Ave. N., Birmingham, Ala.	W. J. Miller, Dept. of Elec. Engg., University of Alabama, University, Ala.



The Ideal Approach to SSB...

Eimac Ceramic Tetrodes from 325 to 11,000 watts

Generating a clean SSB signal is one thing . . . amplifying it to the desired power level with stability and no distortion is another. A modern Class AB_1 final amplifier designed around an Eimac ceramic-metal tetrode is the ideal answer to the problem. The Eimac ceramic linear amplifier tubes shown above — the 4CX250B, the 4CX300A, the 4CX1000A and the 4CX5000A — offer the high power gain, low distortion and high stability that is needed for Class AB_1 operation. Each has performance-proved reserve ability to handle the high peak powers encountered in SSB operation. Efficient integral-finned anode cooler and Eimac Air System Sockets keep blower requirements at a minimum and allow compact equipment design. And, all four incorporate the many advantages of Eimac ceramic-metal design, which assures compact, rugged, high performance tubes.

The high performance and reliability of Eimac ceramic tetrodes make them the logical starting point in the design of compact, efficient single sideband equipment.

Write our Application Engineering Department for a copy of the technical bulletin "Single Sideband"

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

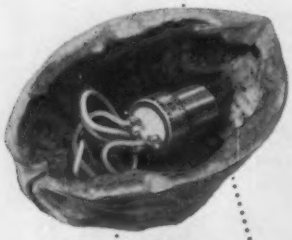
***Eimac First** with ceramic tubes that can take it*

Eimac®

CLASS AB_1 SSB OPERATION

	4CX250B	4CX300A	4CX1000A	4CX5000A
Plate Voltage	2000 v	2500 v	3000 v	7500 v
Driving Power	0 w	0 w	0 w	0 w
Peak Envelope Power . .	325 w	400 w	1680 w	11,000 w

miniaturization in a nutshell



STATHAM MODEL P222 flush diaphragm pressure transducers. DIMENSIONS: .25" diameter x .47" long. WEIGHT: 3 grams, approximately. RANGES: 0-10 to 0-200 psia, psig, or psid; ±5 to ±25 psid. NON-LINEARITY & HYSTERESIS: Not more than ±1% fs. TRANSDUCTION: Resistive, complete bridge; Statham unbonded strain gage.

STATHAM MODEL A52 linear accelerometer. DIMENSIONS: .32" wide x .35" high x .84" long. WEIGHT: 8 grams, approximately. RANGES: ±5 to ±100 g. NON-LINEARITY & HYSTERESIS: Not more than ±1% fs. TRANSDUCTION: Resistive, complete, balanced bridge; Statham unbonded strain gage.

Statham's accurate, reliable line of pressure transducers and accelerometers are designed to meet the exacting requirements of today's missile and supersonic aircraft programs. Let us assist you with your instrumentation problems.

*Model shown actual size.

Complete data are available upon request.

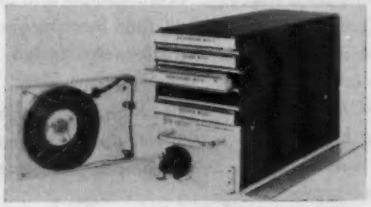
Statham
INSTRUMENTS, INC.
12401 W. Olympic Blvd., Los Angeles 64, California

NEW PRODUCTS

Midget Power Inverter. An inverter for converting d-c to 115 volts a-c for running utilities and equipment in remote locations has been announced by Lincoln Electronics, 1173 Lincoln Ave., Anaheim, Calif. This new midget-size power unit employs an exclusive transistorized power circuit to convert d-c battery power to a-c for running test equipment, light plants, etc., all from one source. It has no moving parts, no brushes, bearings, or vibration contacts. Conversion efficiency is rated at 85%. For more information contact the manufacturer.

Optical Gauge. New ease, speed, and accuracy in precision measurements are claimed for a new optical gauge developed by Bausch & Lomb Optical Co., 91449 St. Paul St., Rochester 2, N. Y. An all-purpose inspection and quality control instrument, the *DR-25* (direct reading) optical gauge measures depth, thickness, height, and diameter. Measuring range of the *DR-25* is continuous from 0 inch to 3 inches, with no masters or set gages needed. Measurements are read directly on an illuminated, magnified scale graduated in clearly defined least-reading intervals of 0.0001 inch, with an accuracy of 0.000025 inch. The optical gauge is distributed in the United States through the Do-All Company, Des Plaines, Ill.

Aerotape. This recorder–reproducer is one of the first modular airborne packages permitting record, erase, and playback in a single unit. Designed primarily for military applications, this miniature magnetic tape device can be adapted to record or reproduce, single or dual-track, radio or radar signals, intercommunication and microphone information, flight test data, entertainment programs, etc. The tape-magazine consists of a single-reel of tape that functions on the unique principle



of continuously reeling upon its own periphery while simultaneously unwinding off a smaller center-hub in an endless loop. For further information on Aerotape contact Technical Products Division, Packard-Bell Electronics Corporation, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

High-Heat Potting Compound. Helix Potting Compound *P-460*, a new 100% Epoxy resin compound offering extreme hardness and a wide temperature range from —80F to +450F, has been announced by the Carl H. Biggs Company, 2255 Barry Ave., Los Angeles 63, Calif. The new compound is poured cold, cures in about 2 hours at room temperature, and offers less than 1% cure shrinkage. *P-460* has good dielectric strength and a very low water absorption factor, making it ideal for encapsulating electrical components vulnerable to moisture and fungus.

Industrial Pocket Microscope. Hardly bigger than a fountain pen, this handy little instrument is said to have a thousand uses in production, engineering, in the laboratory, or shop. Because of its small size of only 5¾ inches long, it is easily carried in the pocket. Contact Edmund Scientific Co., Barrington, N. J.

Ageproof Film. This tearproof drafting medium with unique drafting qualities is announced by Eugene Dietzgen Co. According to exhaustive laboratory tests, this new material withstands usage that would destroy any other drafting media. Repeated erasures, folding, and handling have virtually no effect on the drafting surface of Ageproof Film. According to the company, prices are comparable to conventional tracing cloth. For further information about Ageproof Film and its many uses, write to Dept. E-10, Eugene Dietzgen Co., 2425 N. Sheffield Ave., Chicago 14, Ill.

Standard Case for Pulse Transformer Packages. A new standard plastic case specifically designed to eliminate the mounting and encapsulating problems of a wide range of pulse transformers has been announced. The case, a complete pulse transformer package rather than just the encapsulation shell of former types, has four special features: custom fit for all sizes of transformers, unobstructed access for assembling and wiring the components, a leak-resistant press-fit seal, and a special keyway for identifying connectors and inserting the package. For further information contact The Milton Ross Metals Company, Davisville Road, Southampton, Pa.

Automatic Square-Root Integrator. Designed to meet instrumented system needs of flow measurement, this Model *26* compact square-root integrator provides a continuous means of automatically totaling flow. Specifically designed for use in standard flowmeters that utilize the output of conventional sensing elements, Librascope's Square-Root Integrator has a wide range of applications, including that of pressure correctors on positive displacement meters. The new unit can also be adapted to miniature strip chart flow recorders, forming an electro-mechanical integrator. Utilizing a double disc and ball integrating mechanism, a recent company development, the Model *26* square-root integrator fulfills the needs for accurate means of measuring flow. For additional information about the Model *26* square-root integrator, contact Librascope, Inc., Commercial Division, 40 E. Verdugo Ave., Burbank, Calif.

(Continued on page 20A)

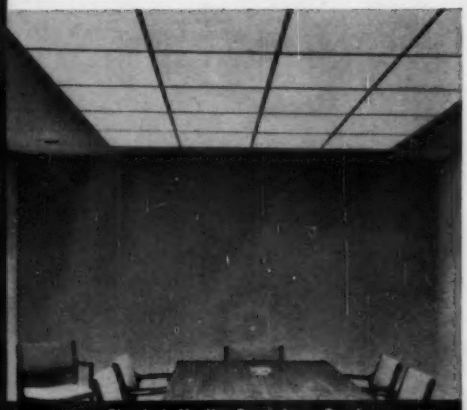
Airways Sales Office... Recessed Luminaires

Now...a Nationwide Trend to

HOLOPHANE 2 Ft. Square Prismalume* Controlens*

- **Setting New High Levels of Fluorescent Lighting Efficiency**
- **Maximum Light Control... High Output...Low Brightness**
- **Sparkling Appearance**

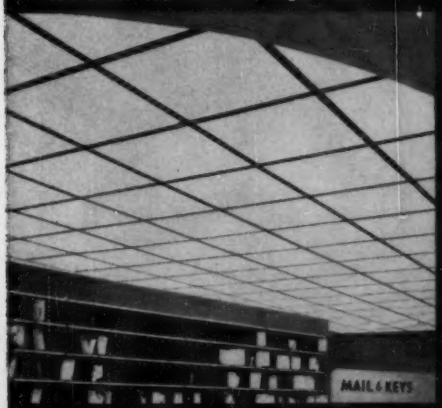
Bank Offices: Continuous Runs; Hinged Frames



Director's Meeting Room: Large Panel

Day by day, increasing numbers of important fluorescent installations feature HOLOPHANE—2 Ft. Square PRISMALUME CONTROLENS... The range of application is wide: offices, banks, stores, lobbies, schools, salesrooms...Equally varied are the forms of luminaires: in large ceiling panels, in continuous runs, in groupings...Wherever it is used this CONTROLENS creates the pleasant feeling that something new and different has been achieved in lighting. Made of Prismalume (acrylic plastic) it affords crystal clarity, color stability, lightness in weight, economical maintenance. The prismatic light controlling features (not mere diffusing elements) provide highest quality illumination, with visual comfort.

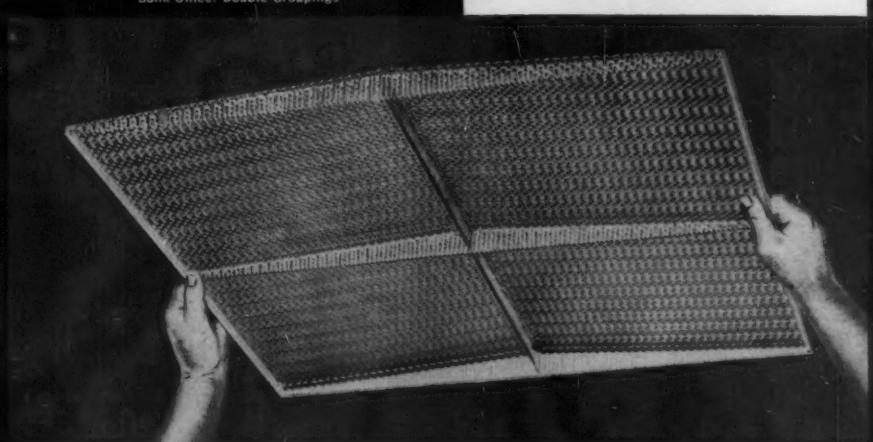
Write for Complete Engineering Data



Hotel Lobby: Large Panel

Bank Office: Double Groupings

Trust Co.: 4 ft. Square Surface-Mounted Luminaires



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For industry, power plants and utilities, Kirk & Blum can produce any type of metal enclosure . . . quickly and economically.
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3204 FORRER STREET, CINCINNATI 9, OHIO

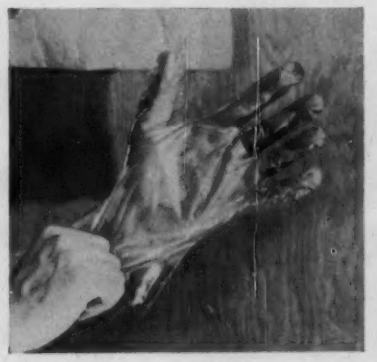
New Products

(*Continued from page 18A*)

New Tape Patterns. Six new patterns have been added to the Chart-Pak, Inc. standard line of narrow Curve Line pressure sensitive tapes. These standard patterns are all available in combinations of black on white, red on white, blue on white, green on white, and black on transparent tape. Copies of a new, illustrated folder may be had without obligation by writing Chart-Pak, Inc., 1 River Rd., Leeds, Mass.

Sapphire Valve Poppet. A relief valve, by Whittaker Controls Division of Telecomputing Corporation, uses a sapphire ball as a valve poppet. The sapphire ball is manufactured by Linde Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N.Y. This particular valve assembly was designed to relieve pressure from the tank of a space vehicle. In operation, it will be required to withstand frequent severe shock while maintaining a very low leakage over an extremely wide temperature range. The Linde sapphire ball was chosen for this critical application because of its polished surface and ability to withstand continual hammering against a hard metal seat. Its extreme hardness prevents scratching, erosion, and general disfigurement, thereby insuring minimum leakage.

Handgards. New plastic gloves, rugged enough to be reusable and inexpensive enough to be disposable, have been announced for industrial use. The gloves, available in large, medium, and small sizes, are packaged in convenient rolls of 12 to 1,000. Price in rolls of 1,000 is about 3 cents per glove. Known as Handgards, the polyethylene gloves for industrial use are waterproof, pre-talcumed, and do not impair the sense of touch as do gloves of



other materials. With all the advantages of polyethylene, such as resistance to acids, dyes, solvents, and most chemicals, Handgards have been cleared for use with radioactive materials by the University of California Radiation Laboratory. Information on Handgards can be secured from Plasticsmith, Inc., Box 415, Concord, Calif. or from Plasticsmith, Inc., Chicago Daily News Building, Chicago, Ill.

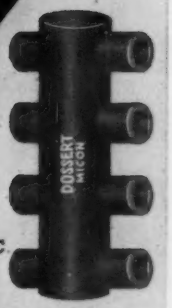
(*Continued on page 22A*)

DOSSERT UNDERGROUND CONNECTORS...

the versatile line

featuring:

- Fully molded, no factory taped joints.
- Insulated with MYPAR* rubber for higher quality and longer life, or MYPRENE* rubber for higher temperature resistance, and greater resistance to acids and oils.
- Made of high conductivity copper, insuring cool operation.
- Interchangeable with all standard underground connectors and their component parts.
- Made to fit standard compression tools.



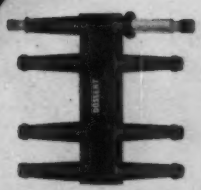
MICON* type MC

MICON COMPONENTS

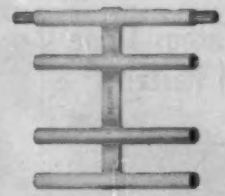
Tapered Compression Sleeve type C

Cable Receptacle type MA

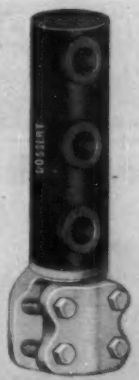
Insulating Sleeve for MICON Outlet type MIS



Insulated Crab Connector type CBR



Uninsulated Crab Connector type CBN



MICON Stud Connector type MCBS

Limiter Link Assembly type LLA

Limiter Link Assembly type NLRA

Terminal Lug type DPL

Comp. Coupler type DPC

Comp. Tee Coupler type CRT

*U.S. Reg. Trade Mark

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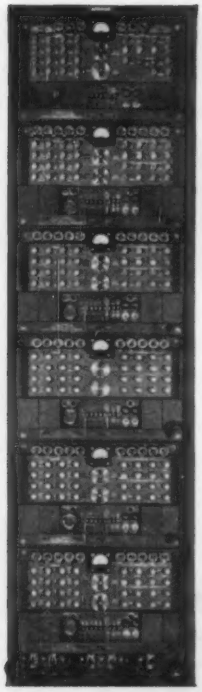

MINIATURIZED CARRIER TELEPHONE SYSTEMS FOR RADIO AND 4-WIRE CABLE

FOUR OR 24 CHANNELS

Two miniaturized voice-multiplex systems providing four or 24 voice channels over radio or 4-wire cable are available. They have many advantages over earlier designs: high performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type only, low operating cost, low maintenance and high reliability.

These systems provide a voice-channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options.

The basic unit provides an order-wire and 4 carrier-derived channels. These units can be stacked in groups of 2, 3, 4 or 5 by means of a group modem to provide 9, 14, 19 or 24 channels. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. Moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

24-channel carrier-telephone terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

RADIO ENGINEERING PRODUCTS
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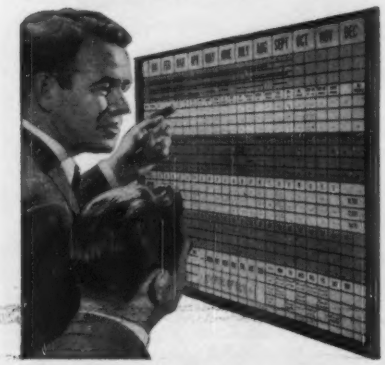
TELEPHONE UNiversity 6-6887
CABLES RADENPRO, MONTREAL

How To Get Things Done Better And Faster



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- ☆ Gives Graphic Picture — Saves Time, Saves Money, Prevents Errors
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Rubber and Plastics Industries Conference

(April 1957)

The Ninth Annual Conference on Electrical Engineering Problems in the Rubber and Plastics Industries was held in Akron, Ohio, April 8 and 9, 1957.

The conference was sponsored by the Subcommittee on Rubber and Plastics Industries of the AIEE Committee on General Industry Applications.

There are eight papers with discussions in publication T-99.

104 pages. Price: $3.00. Write to:

Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

33 West 39th Street
New York 18, N. Y.

New Products

(Continued from page 20A)

New Drafting Pencil. A pencil, developed especially to enable draftsmen to get all the potential advantages from the new matte-surface Mylar film, has been announced. Registered under the name Duralar, it will shortly be on sale at engineering and drafting supply dealers only. This new lead is completely smearproof on matte-surface Mylar tracing film, yet erases perfectly. The tracings can be cleaned with soap and water without loss of clarity. Since Duralar does not smear, tracings can be printed over and over without loss of detail. The absence of graphite's light-reflecting qualities assures sharp, clear, photographic reproductions, even on microfilm. Reproductions of Duralar tracings on Mylar are equivalent in quality to prints made from India Ink tracings which, of course, require much more drafting time. Samples for testing and evaluation are available by request on business letterhead from J. S. Staedtler, Inc., 25 DiCarolis Ct., Hackensack, N. J.

360-Degree Warning Beacon. A powerful, 360-degree revolving beacon producing one of the brightest lights used for industrial emergency warning purposes has been designed by Federal Sign and Signal Corporation, 8700 S. State St., Chicago 19, Ill., as a safety alarm and visual communications signal. Mounting an intense, 200-watt, sealed beam lamp, the model *271* Beacon Ray produces 60 brilliant flashes per minute which carry over long distances both indoors and outdoors. Two models are available, the *271* for surface mounting, and the *271A*, furnished with a 1¼-inch pipe flange for stanchion mounting.

Nonflammable, Non-toxic Rust Preventive. Effectively packaged in an economical 16-ounce Aerosol container, Anderol *L-536* rust preventive gives positive protection from rust for all types of metal products and machinery. Spray application provides a continuous light film protection that, in most cases, does not have to be removed before use or final finishing. *L-536* rust preventive is available from Lehigh Chemical Company, 10 Flatlands Rd., Chestertown, Md.

Vac-U-Mation. This combination vacuum plate lifter and feeder lifts and moves single or multiple plate loads from 2,000 to 10,000 pounds by means of vacuum alone. No magnets, chains, slings, or lifting devices of any kind are used, only vacuum. The new Vac-U-Mation plate feeder can be supplied with extension arms making it possible to lift and move heavy plates 10 feet wide by 40 feet long, weighing 10,000 pounds or more. The unit rides on rails and can be made semiautomatic or fully automatic with remote controls. For descriptive literature write to Vac-U-Mation Division, F. J. Littell Machine Co., Dept. 1-R, 4127 N. Ravenswood Ave., Chicago 13, Ill.

(Continued on page 40A)

A COMPLETE LINE OF SPACE-SAVING RELAYS

UP TO 4 CONTACTS
2 Normally Open
2 Normally Closed
Measures only
3-5/16" high x 2-5/8" wide!

UP TO 6 CONTACTS
4 Normally Open
2 Normally Closed
Measures only
3-11/16" high x 2-13/16" wide!

NEW!

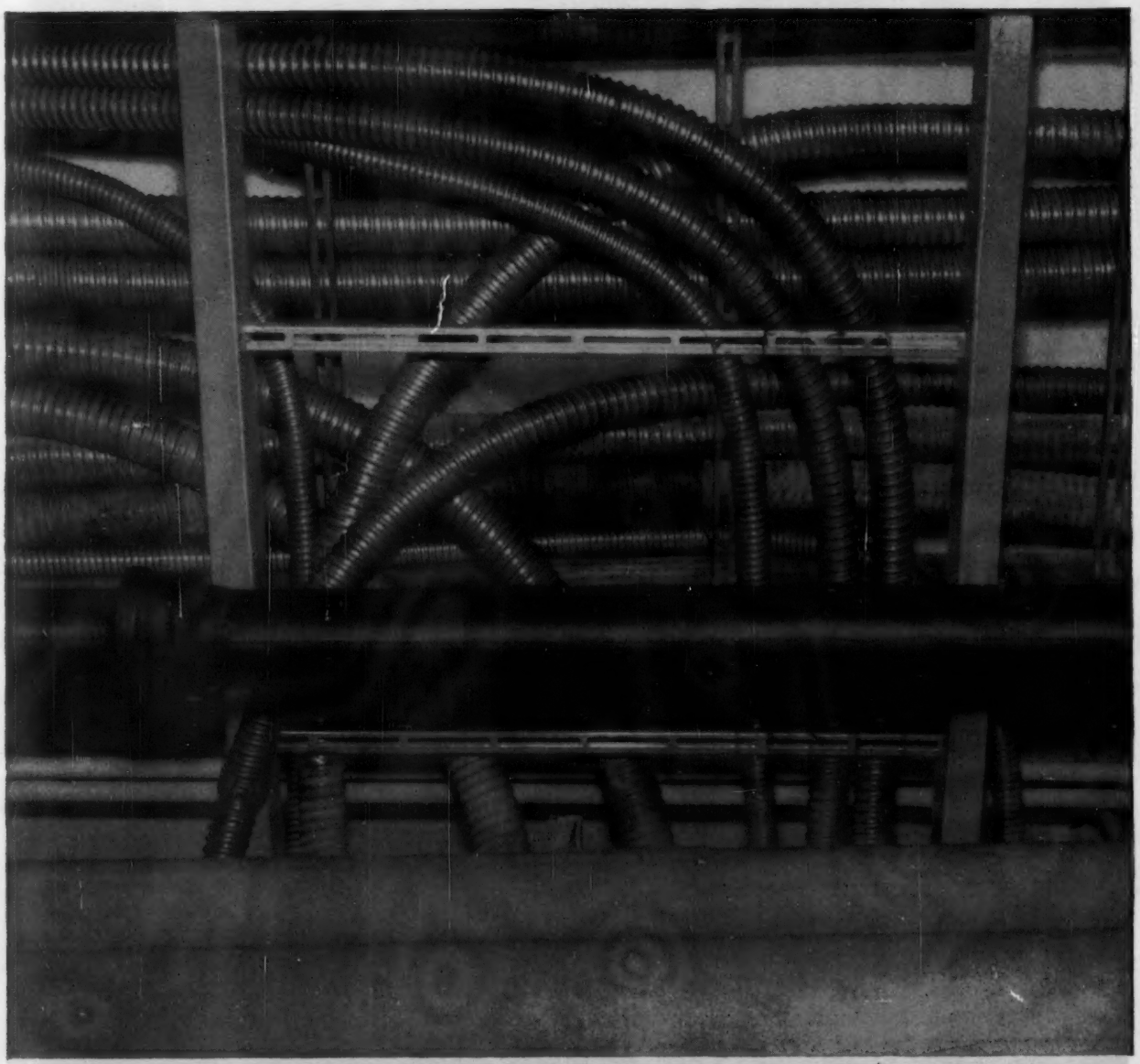
UP TO 10 CONTACTS
Either 6 Normally Open and
4 Normally Closed or
8 Normally Open and
2 Normally Closed
Measures only
5" high x 3" wide!

- 600 VOLTS • 10 AMPERES • LONG LIFE
- ALL THREE SIZES HAVE IDENTICAL MOUNTING HOLE DIMENSIONS

for the Complete Story, write for Bulletin 8501-D
Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY



CREDITS—Owner: SCHLEGEL MANUFACTURING COMPANY, Rochester, New York; **Electrical Contractor:** T. H. GREEN ELECTRIC COMPANY, Rochester, New York; **Builder:** JOHN W. RYAN CONSTRUCTION, New York City; **Architect:** SERGE P. PETROFF, New York City; **Structural Engineer:** STROBEL AND SALZMAN, New York City; **Construction Engineer:** GUY B. PINERO, New York City.

USS Tiger Brand Electrical Wire & Cable

A standard cable for every special job

- Asbestos Wire and Cable
- Mold Cured Portable Cord
- Shovel & Dredge Cable
- Paper & Lead Cable
- Varnished Cambric Cable
- Interlocked Armor Cable
- Special Purpose Wire & Cable
- Aerial, Underground and Submarine Cable

You could do this with conduit but think what it would cost!

JUST IMAGINE THE MAN-HOURS that would have been required to bend and contort steel conduit to fit this maze-like 480-volt, 3-phase, 4-wire industrial distribution system. We don't know how much more a conventional installation of cable-in-conduit would cost because Schlegel Manufacturing Company chose the sensible way out: flexible, easily installed USS Tiger Brand Armorlokt Interlocked Armored Cable.

Saves time—We know, from experience on other jobs, that a conduit system would have required about twice as much time to install. It would probably have required larger size cable, because of the higher voltage drop. It would have required about three times as much material.

Easily changed—Most important, though, this Armorlokt installation gives Schlegel Manufacturing Company a far more flexible and *revisable* installation. Machines can be moved and the electrical distribution system easily adapted to the changes when accessible, easily traceable Armorlokt is used.

Cuts cost—Past experience shows that a Tiger Brand Armorlokt installation on factory-made racks can cut installed cost as much as one half compared to conventional distribution systems. Also, it requires less space—often a major consideration in crowded factory areas. It can be installed inside or outside . . . is available in voltage ratings from 110 to 15,000 . . . with galvanized or stainless steel, aluminum, or bronze armor . . . with polyvinyl chloride jackets *over the armor* in especially corrosive applications.

USS, Tiger Brand and Armolokt are trademarks

Write for complete facts. Or call the nearest American Steel & Wire Sales Office. American Steel & Wire, General Offices: Cleveland 13, Ohio.

Step-down. Incoming voltage to Schlegel Manufacturing Company's main plant substation is 33,000 volts. This is stepped down to 480/277 volts, 3 phase, 4 wire, and distributed to unit substations like this one, where voltage is stepped down to 240 volts and distributed to plant electrical equipment. 600-volt Armorlokt was used throughout, in sizes #2 AWG, 2/0, 4/0, 350 MCM, and 500 MCM. Most of it was 3-conductor cable. Armor was galvanized steel. Schlegel manufactures beading fabric for doors on Ford and General Motors cars . . . also makes industrial fabric for other applications.

American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad

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OFFER YOU:

Excellent dielectric strength— electrical properties remain constant from −130°F to +500°F.

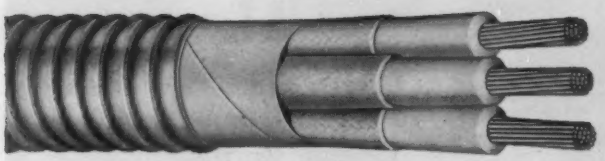
High heat resistance — better than any type rubber insulation. Long service life in temperatures to 125°C (power cables) and 200°C (other applications).

Excellent moisture resistance — unrestricted applications in wet or dry locations — equal to the best grades of rubber. No lead sheath required.

Greater ozone resistance than the best grades of rubber insulated cables.

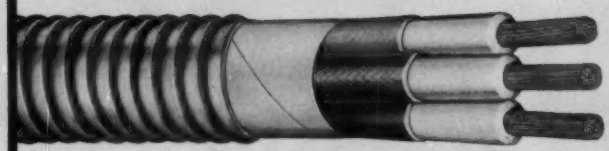
Excellent resistance to chemical attack — being chemically inert, silicone rubber insulations resist effects of lubricating oils and most corrosive atmospheres.

Long life — excellent resistance to weathering and aging.



600 and 5000 VOLT MULTI-CONDUCTOR POWER CABLE

Silicone rubber insulated power cable combined in a 3 or 4 conductor conduit, with interlocked armor overall . . . easily installed with simple supports . . . eliminates conduit . . . greater current carrying capacity for economical power distribution.



MULTI-CONDUCTOR CONTROL CABLE

For use in steel mills, power stations, boiler rooms, automotive, ceramic and glass plants as well as other industries where control and signal circuits or control equipment are exposed to high ambient operating temperatures.

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WIRES

SILICONE RUBBER INSULATED POWER CABLE 600 and 5000 VOLTS

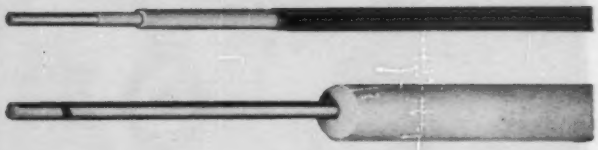
For high temperature circuits either in wet or dry locations, exposed or in conduit. This cable is recommended for use in steel mills, power stations, heat treat areas, boiler rooms, foundries, smelters, etc.

MOTOR LEAD and APPARATUS WIRES

For leads to motors, transformers, etc., requiring a flexible wire in high temperature locations or applications.

APPLIANCE and FIXTURE WIRES

For use in wiring high wattage units when operating temperatures reach 150°C and 200°C. Lighting fixtures, clothes dryers, electronic equipment, stoves, water heaters, ovens, therapeutic devices, space heaters are among the many products for which these wires are recommended.

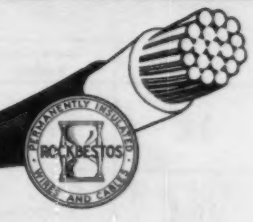


HEATING CABLES and DEFROSTING WIRES

Heating cables are ideal for use in pipe heating, surface heating, roof de-icing and soil heating.

Defroster wires being odorless and tasteless are perfect for use as rapid defroster heating element in electric refrigerators and freezers.

ROCKBESTOS

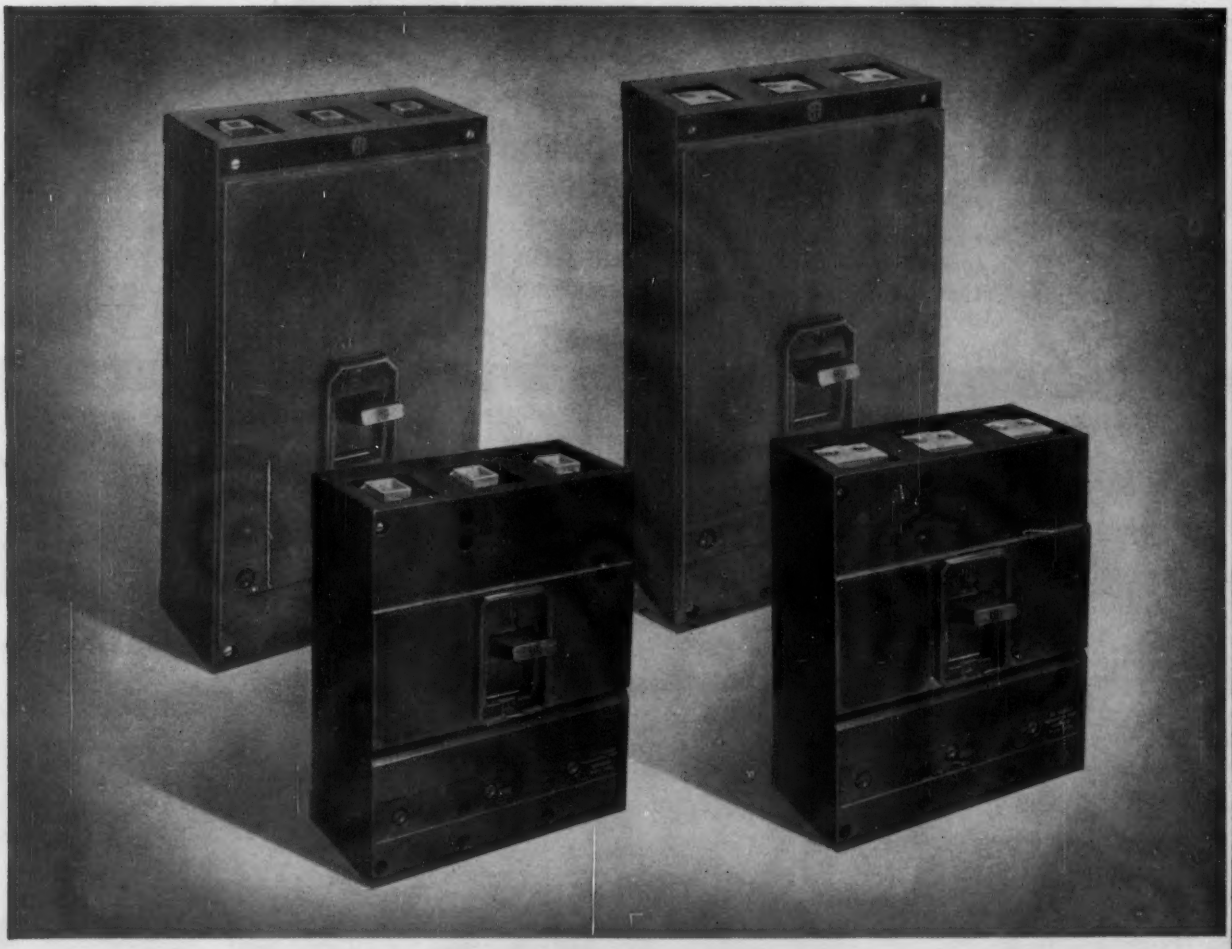


For complete details on Rockbestos Silicone Rubber Insulated Wires and Cables send for Catalog SR58.

Announcing

TWO NEW I-T-E Molded

New, compact JK and JKL molded case circuit breakers are the two latest additions to industry's most complete and diversified line

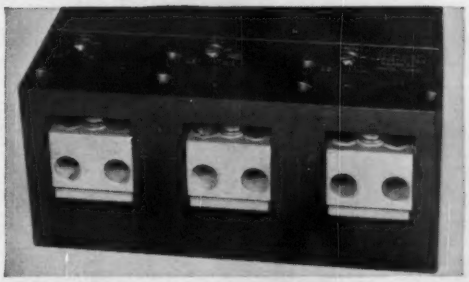


SPECIFICATIONS

	Continuous Rating	Interchangeable Trip Unit	Interrupting Rating	Front-removable lugs	Dimensions
JK	70-225 amp	yes	(at 600 v) 25,000 amp (at 240 v) 30,000 amp	yes	9 x 11 x 4 1/16 in.
JKL	125-400 amp	yes	(at 600 v) 25,000 amp (at 240 v) 40,000 amp	yes	9 x 11 x 4 1/16 in.

Case Circuit Breakers!

- **Interchangeable trip unit construction**
- **225 and 400 amp continuous ratings**
- **25,000 amp interrupting ratings**
- **Exclusive new front-removal lug design**



I-T-E Molded Case Circuit Breakers have exclusive, completely enclosed terminals for greater safety.

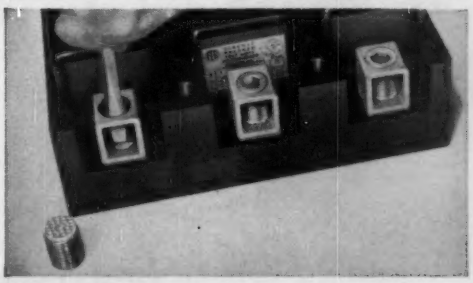
:::in a size only two-thirds that of breakers previously required

As one of the pioneers in the electric circuit breaker field, I-T-E has consistently maintained its leadership—not only in developing new products to meet the growing needs of industry, but in constantly seeking ways to improve existing designs.

The new JK and JKL I-T-E Molded Case Circuit Breakers are but one more example of I-T-E advances in the interest of continued improvement. They have the same famous built-in I-T-E "extra quality—at no extra cost."

These new JK and JKL breakers are identical—performance-wise—with existing K and KL breakers, and not only do they represent space economy, but in certain instances an actual saving in initial cost. Compare with any other equally rated breaker.

See your I-T-E distributor for details on these new breakers or write I-T-E Circuit Breaker Company, Small Air Circuit Breaker Division, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada, Eastern Power Devices Ltd., Port Credit, Ontario.



New I-T-E JK and JKL breakers have an exclusive lug which is installed from the front of the breaker. This assures easy interchange of trip units when the breaker is in place.

I-T-E JK and JKL frame breakers provide external front adjustable instantaneous trip design, an I-T-E exclusive.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

OPERATION upturn
Buy now for extra values
GENERAL ELECTRIC
PROJECT EHV: Five-million-dollar evidence of General Electric's confidence in the continuing growth of the electric power industry.

General Electric announces...

PROJECT EHV

An operating system for study of all aspects of extra-high-voltage transmission 460 to 750 kv

General Electric, with counsel from the electric utility industry, will build and operate a prototype EHV transmission system. Objectives are to help extend the electrical industry's knowledge of high-voltage phenomena and to anticipate the equipment that will be needed when EHV transmission becomes standard practice.

The line, 4½ miles in length, will parallel and be made a part of the Pittsfield-Lee portion of the Western Massachusetts Electric Company's system. Initial operation in early 1960 will be at 460 to 500 kv a-c, rising later to the 600- to 750-kv range. In 1961, as tests proceed at the 650-kv level, power will be diverted from the adjacent segment of the WMECO line through the EHV system.

Others co-operating in the project, in addition to Western Massachusetts Electric Company, are Stone & Webster Engineering Corporation, Aluminum Company of America, and American Bridge Division of United States Steel.

An Advisory Council representing electric utilities, will help determine exact project parameters and the nature and scope of research.

Expected areas of study include:

- Economics of various a-c super-voltages
- Lightning and switching surge performance
- Effects of conductor size, bundle and phase configuration.
- Mechanical performance of line
- Effect of conductor temperature
- Corona loss, radio and television interference
- Reduced basic impulse insulation levels

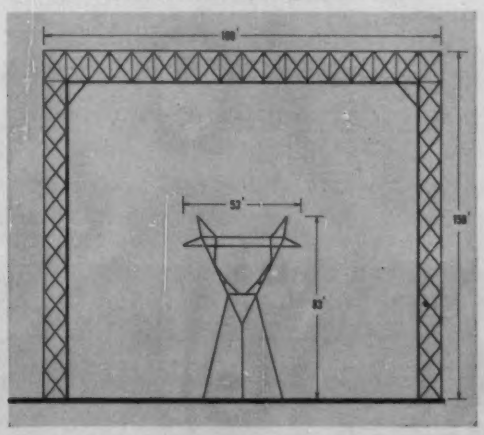
A wide variety of measurements with 200 instruments will be made at 15-minute intervals during all tests. Data will be processed through the 705 electronic data-processing machine at General Electric's Power Transformer Department, which is co-ordinating the project. Data will be correlated by analytical studies, model investigations and laboratory research in many G-E Departments.

For further information on PROJECT EHV, contact your G-E Representative or write for bulletin GED-3262, General Electric Co., Section 421-56, Schenectady 5, N. Y.

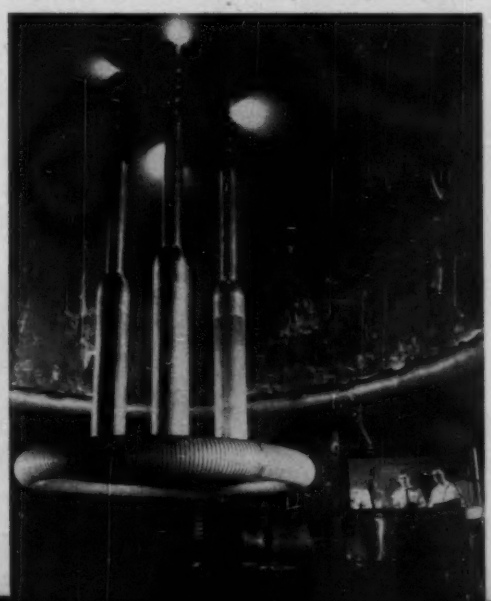
Progress Is Our Most Important Product

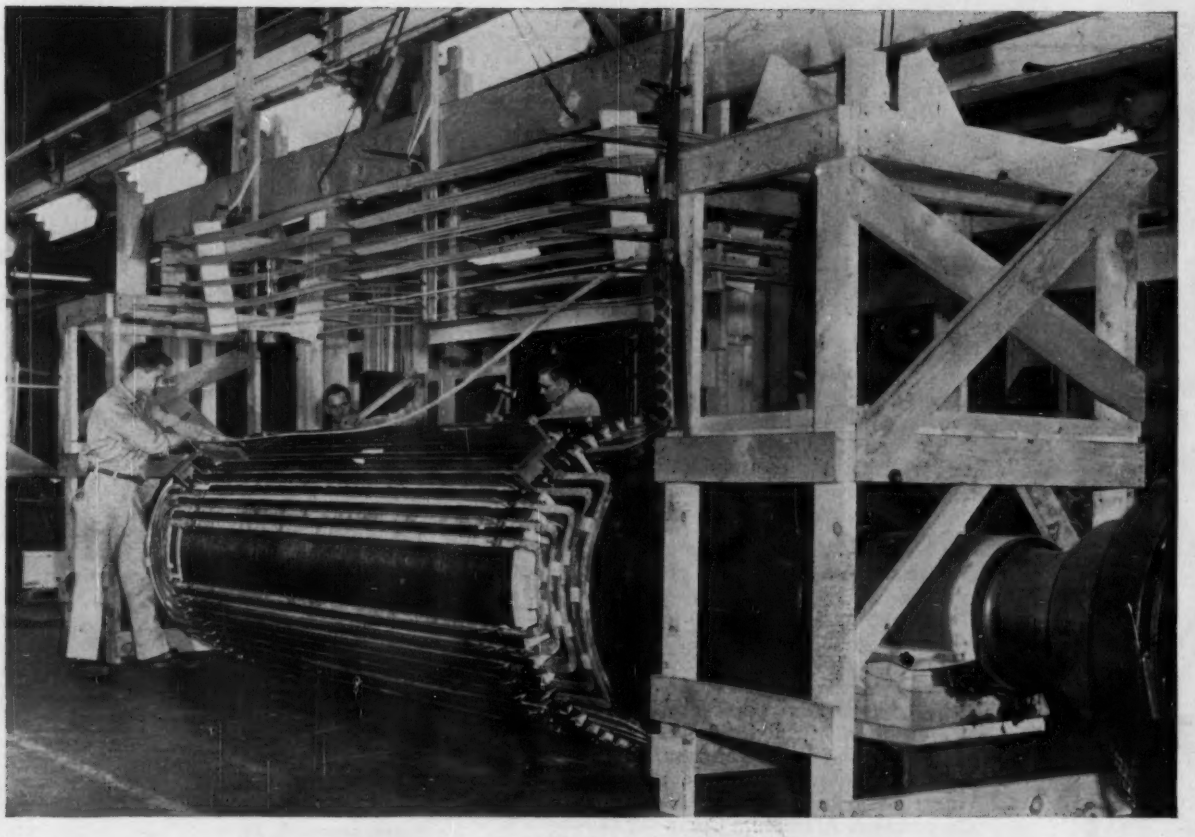
GENERAL ELECTRIC

PROJECT EHV portal-type towers, 158 feet high, 180 feet wide (here contrasted with typical present 230-kv towers), will allow varied conductor spacings and clearances.



PRELIMINARY STUDIES of apparatus and system are now under way. Here sample conductor bundle is tested for radio interference at G.E.'s Pittsfield High Voltage Laboratory.





Experienced craftsmanship insures top quality when NATIONAL rewinds a turbo generator field

There's no substitute for experience when it comes to rewinding a turbo generator rotor. It requires a craftsman with skill which is acquired only through long experience.

National has many such craftsmen with years of experience in rewinding large fields. National has the manufacturing facilities to give these craftsmen the best in coils and materials to work with. That's why, when you need fast service and absolutely top quality rewinding, you can count on National. National experience with all types of equipment (including that of foreign manufacture) and the pride in fine workmanship which is typical of National's master craftsmen are your guarantee of a winding which will give long years of trouble-free service.

For complete details on why National is unsurpassed for service and quality on windings for any large rotating electrical equipment, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

WON'T SMEAR ON MYLAR®!

Duralar

The only pencil

that **can't smear** on Mylar, that **keeps a point** on Mylar, that **erases** on Mylar. Duralar drawings on Mylar **reproduce** perfectly, **microfilm** without loss and can even be **cleaned** with soap and water.

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send coupon below with business letterhead. Specify whether you wish included a test sample of matte-surface Mylar tracing film. See for yourself how the sensational new Mars Duralar solves your drafting problems. And Duralar is available (pencils, leads and lead holders) in five special new degrees of hardness (K1 to K5).

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Another first from

MARS

J. S. STAEDTLER, INC. HACKENSACK, N. J.

Gentlemen: Please send me FREE

- ☐ The revolutionary new DURALAR pencil
- ☐ Include a sample of Mylar film for testing the DURALAR pencil.

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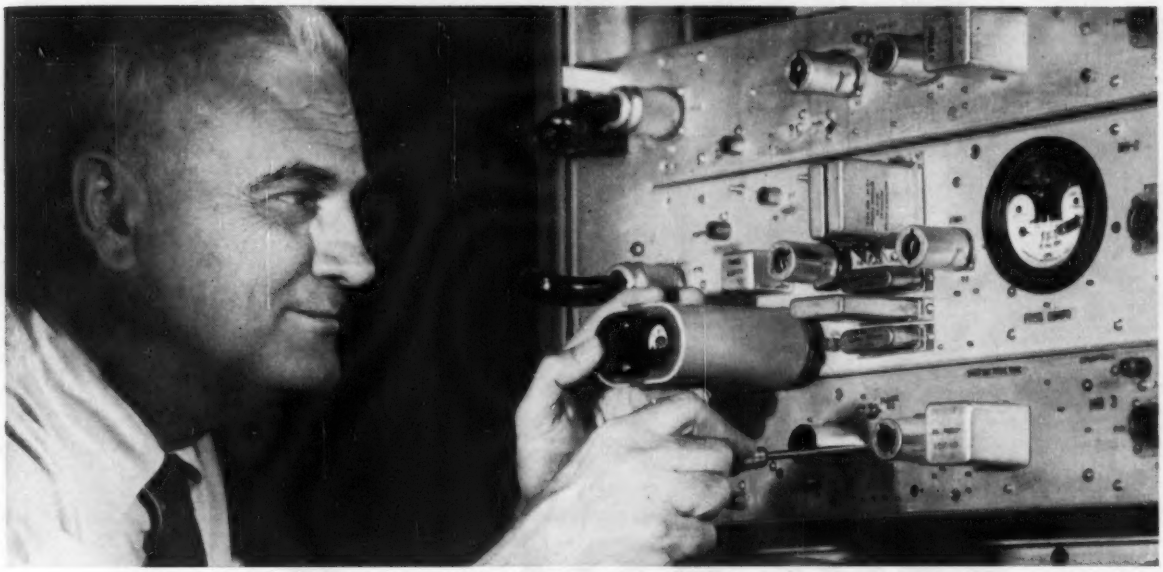
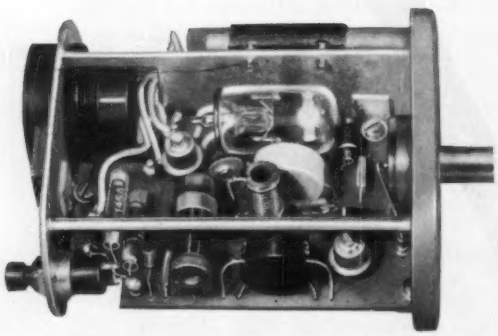
Bell Laboratories Announces Pocket-Sized Frequency Standard for Microwave Systems



Lawrence Koerner, who developed the portable frequency standard, demonstrates how the device can be plugged in at a radio relay station to supply a checking frequency. Battery-powered, the device maintains precision calibration for several months.



Inside the portable frequency standard. Four Laboratories-developed devices make it possible: (1) transistor, which converts the power from a battery to radio frequency oscillations; (2) voltage reference diode, which maintains constant voltage; (3) piezoelectric crystal unit of superlative stability; (4) thermistor, which corrects for temperature variations.

Microwave radio relay systems depend critically on the accuracy of their "carrier" frequencies. At scores of relay stations along a route, carrier frequency oscillators must be checked periodically against a signal from a precise standard.

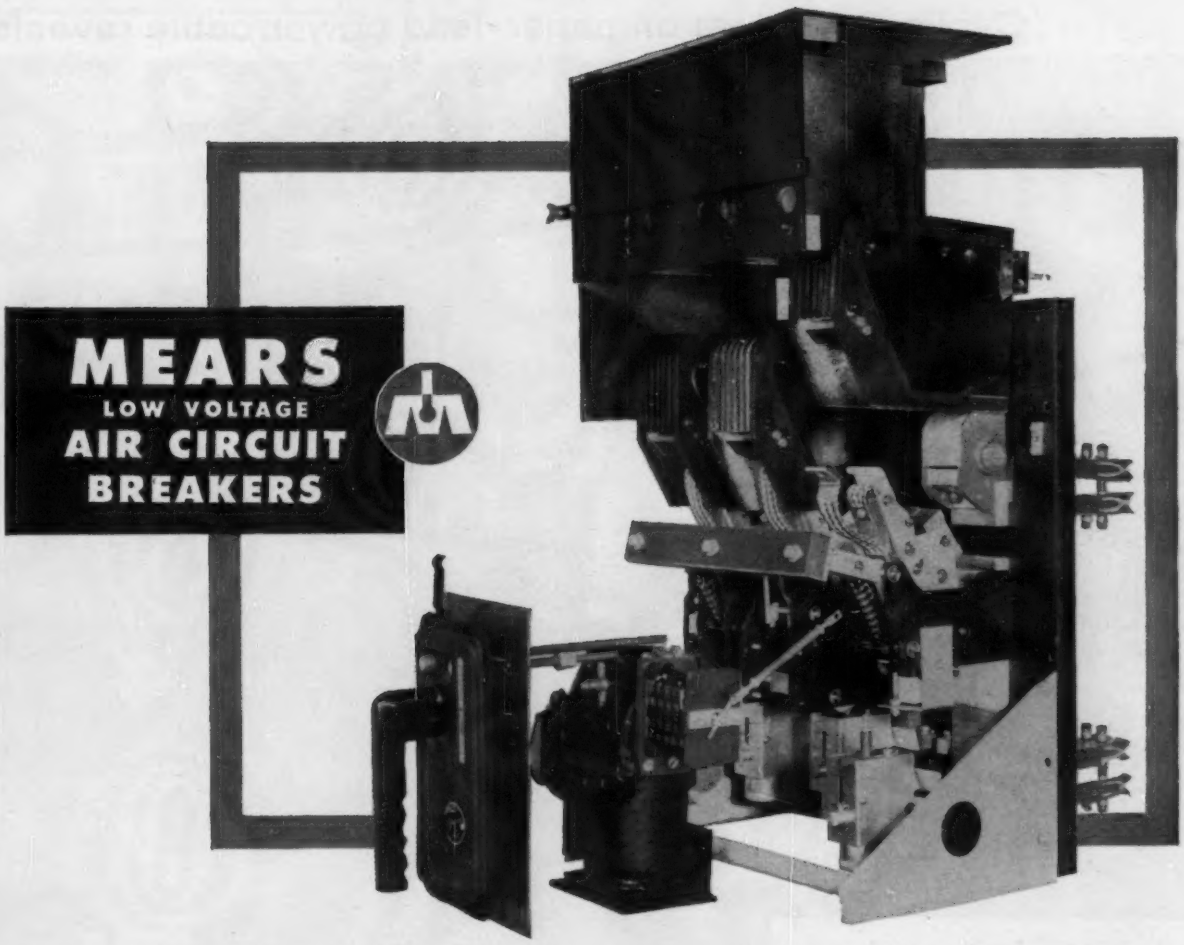
In the past, the maintenance man has had to obtain his checking frequency by picking up a standard radio signal from a government station. This operation takes time—and requires elaborate equipment.

With a new *portable* frequency standard developed by Bell Laboratories engineers, the job is much simplified. To check an oscillator, the portable standard is plugged in, and a button is pressed. In seconds, it supplies a checking frequency accurate to one part in a million.

Until now, such precision in a frequency standard has been obtainable only in a laboratory. The new portable standard makes it available for routine use in the Bell System. First use of the standard will be to maintain frequency control in a new microwave system for telephone and TV, now under development at Bell Laboratories.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



A circuit breaker must be 100% dependable

(or it is 100% worthless)

The dependability of a circuit breaker is something unique. It is built to handle a crisis that may never occur. Unable to flex its muscles regularly, its function is to rest in a state of inactive readiness for years on end. If it fails once it is a *total* failure.

There are two ways to check a circuit breaker's dependability. One is to assess its mechanical design in the light of an engineer's basic knowledge of electromotive and mechanical forces. Another is to look at the record. On both counts Mears invites the most searching inquiry. Many exclusive design features provide an exceptional margin of safety. As for the record—no Mears circuit breaker has ever failed, even after years of suffusion in the abrasive dust of cement mills or the corrosive dust of alumina plants.

UNIQUE FEATURES:

1. Fixed, removable and draw-out units. Mears removable units can be removed from the switchboard without killing the main bus. There are no expensive shutdowns.
2. The widest selection of circuit breakers. Five extra sizes.

TO LEARN MORE ABOUT MEARS AIR CIRCUIT BREAKERS see our representatives:

Garnett Young and Co.: Los Angeles, Phoenix, Portland, Ore., San Francisco, Seattle.
L. H. Jones Co.: Emmaus, Pa.
Slaybaugh-Thompson Co.: Denver.
Tate and Co.: Dallas, Houston, New Orleans.
The Chas. L. Ward Co.: Kansas City, Mo.
L. L. Weldy & Associates, Inc.: Chicago and Milwaukee.
Electric Jobbers Equipment Co.: Minneapolis.
M. H. Gottfried: Mexico City.

Mears circuit breaker features

- . . . Both electrical and manual operation.
- . . . Low operating temperature.
- . . . Sintered silver contacts.
- . . . Shockproof.
- . . . Vertical plane design.
- . . . Dustproof.
- . . . Anti-bounce.
- . . . Operating torque with 300% safety margin.
- . . . Light tripping action.
- . . . Low maintenance.
- . . . Extra wide range of ratings (can be sized to job).
- . . . Only West Coast breaker manufacturer.
- . . . Fast Delivery.
- . . . 100,000 Amp interrupting capacity, 6000 Amp continuous.
- . . . Fixed, removable and draw out units.
- . . . The widest selection; 5 extra sizes.

MEARS
AIR CIRCUIT BREAKERS

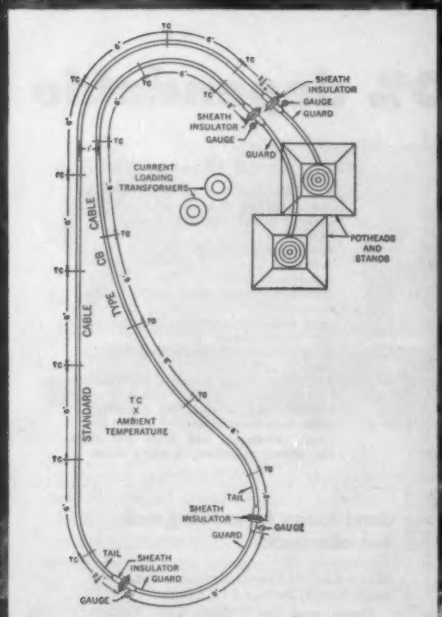
Send today for catalog and test information

Mears Electric Circuit Breakers, Inc.
Swan Island, Portland 17, Oregon

Please send me "Mears Low Voltage Circuit Breakers" catalog:

Name_____
Firm_____
Address_____
City_____ Zone____ State_____

Cyclic aging test on paper-lead power cable reveals



RESEARCH LABORATORY SET-UP for cyclic aging test. Two single-conductor, 69kv shielded-type cables (one standard, one Anaconda Type CB) were spliced together to form a single cable. The cable was then subjected to cyclic aging for 404 daily load cycles. At end of test the two sections were studied—and revealed the results shown in chart at right.

Greater insulation stability...longer cable life with TYPE CB cable

Heat and electrical stress . . . heat and electrical stress—keep it up long enough and insulating oil in ordinary paper cable breaks down.

Anaconda Type CB* (Carbon Black) power cable is different. Special carbon-black tapes continually purify and stabilize the insulating oil over the life of the cable. These carbon-black tapes provide many advantages:

1. Oxidation products are removed.
2. Deterioration is reduced by continuous purification of the oil.
3. Conductor is shielded; strand discharges, and ionization discharges between insulation and sheath are eliminated; maximum stress is reduced more than 25 percent.
4. Destructive energy is reduced because the work function of carbon is much less than that of copper.
5. Surge currents are diminished.
6. Impulse strength is increased.
7. Dielectric strength and life are increased.

The over-all result is not only physical and electrical improvements, but also real economic gains for the user.

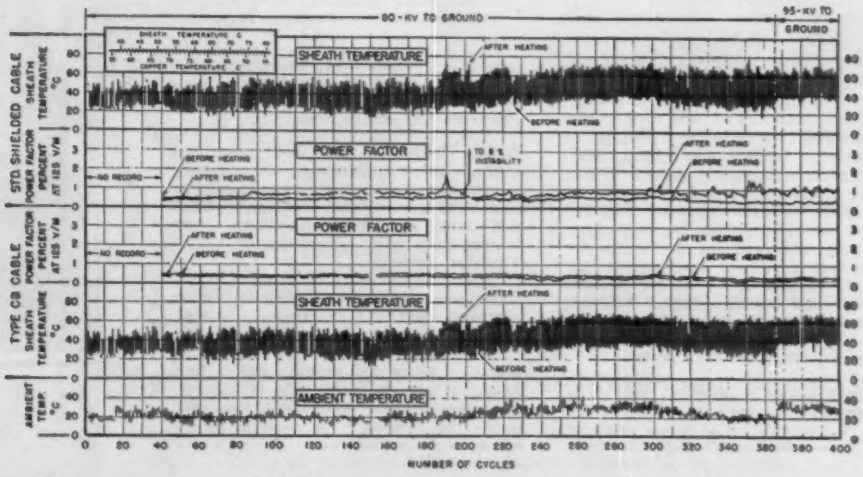
CYCLIC AGING TEST

For dramatic proof, no other test shows stability better than the cyclic aging tests.

The test shown here consisted of subjecting two single-conductor, 69kv shielded-type cables to cyclic aging for 404 daily load cycles. One cable was Type CB, the other a cable of standard construction. Both cables were still in operating condition at the end of the test. The standard cable, however, showed definite signs of aging. The Type CB cable showed no such signs.

WANT TO KNOW MORE? The Man from Anaconda will be glad to give you full information about Type CB cable. See him or write for Bulletin C-89. Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. 56881

*CB—Carbon Black (U. S. Patents 2,102,129; 2,405,853) Reg. U. S. Pat. Off.

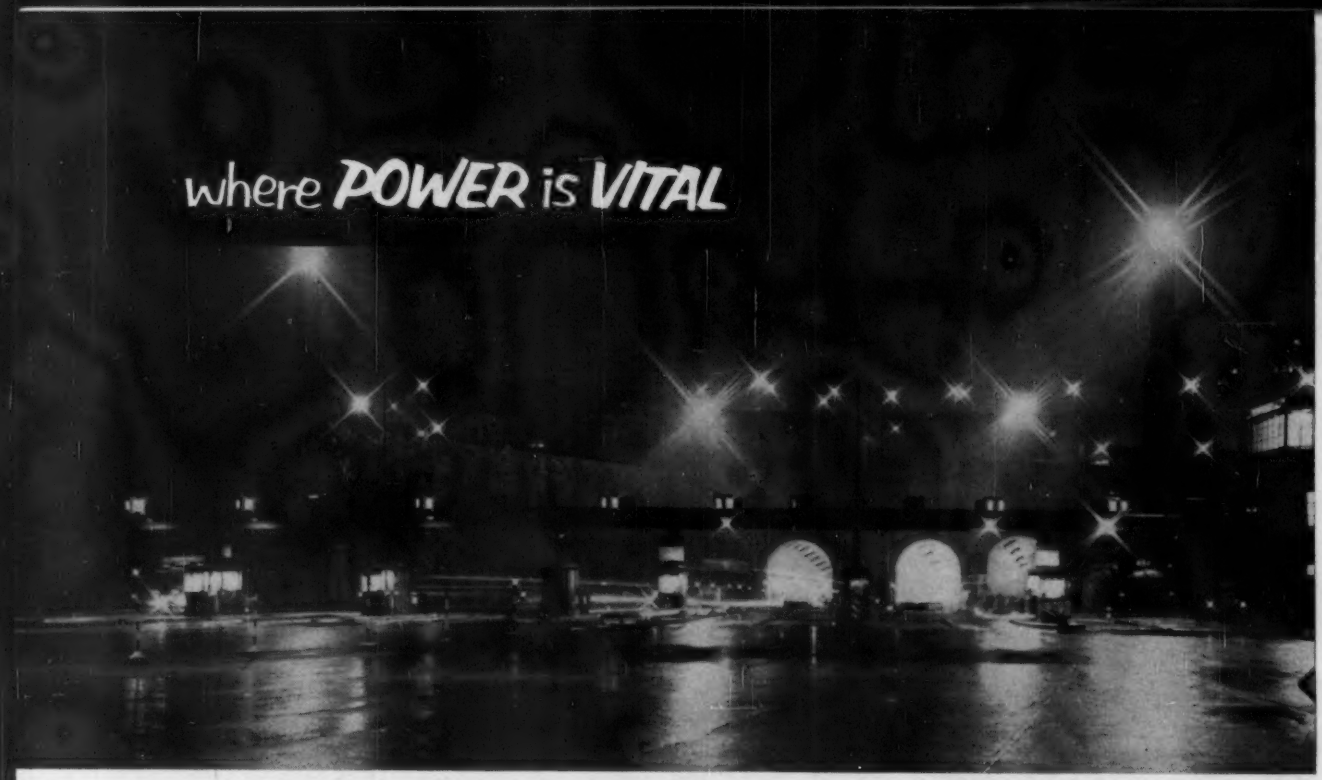

80 - KV TO GROUND
95 - KV TO GROUND
STD SHIELDED CABLE
TYPE CB CABLE
SHEATH TEMPERATURE °C
POWER FACTOR PERCENT AT 185 V/M
AMBIENT TEMP. °C
SHEATH TEMPERATURE
POWER FACTOR
AMBIENT TEMPERATURE
AFTER HEATING
BEFORE HEATING
NO RECORD
TO 8 % INSTABILITY
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400
NUMBER OF CYCLES

CYCLIC AGING CHARACTERISTICS of 1/c, 650 Mcm, 69kv solid-type paper-insulated cable, standard construction compared to Type CB construction. Power factor readings during each cycle show low and constant values for Type CB cable—0.3 to 0.5 percent for both. The standard cable, with the same initial values, increased to over 1 percent at the end of the test. Power factor readings before and after heating during each cycle are also significant. At first, both cables show "after heating" values below those for "before heating." In the standard cable, the trend is reversed (69th cycle) and the "after heating" values are higher to the end. In the Type CB cable, the "after heating" values remain below throughout the test.

LIVE BETTER ELECTRICALLY

SEE THE MAN FROM **ANACONDA**®

FOR **TYPE CB CABLE**



ASCO Remote Control Switches and Transfer Switches assure dual protection for Lincoln Tunnel.

Light or power failure in the Lincoln Tunnel or on its highway approaches could have disastrous consequences – for thousands of cars and trucks pour through the underwater throughway every day. This is why engineers selected ASCO Remote Control Switches and Automatic Transfer Switches in several strategic locations.

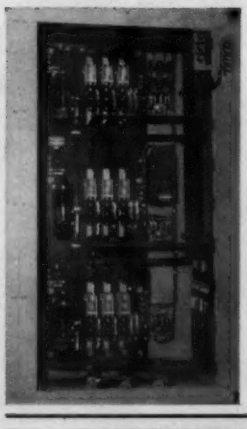
ASCO REMOTE CONTROL SWITCHES help provide the proper voltages to tunnel lighting and adjacent highway lighting. Triple interlocked ASCO Remotes are used for switching the primaries of transformers feeding 800, 1000, 1200 volt fluorescent lighting circuits. Three lighting circuits are required because of the starting characteristics of two fluorescent tubes in series. On cold days, 1200 volts are required to "strike the arc" across a pair of fluorescents. On warm days, only 800 volts are needed. An additional benefit – higher voltages can compensate for lamp aging. Check these advantages of ASCO Remote Control Switches:

• Standard listings in capacities from 30 to 1000 amperes; available to 750 volts AC or DC • Available to 24 poles, single or double throw • Mechanically Held, Electrically Operated . . . unaffected by line voltage conditions; respond only to push buttons. Insure against outages on vital circuits caused by momentary line voltage drops.

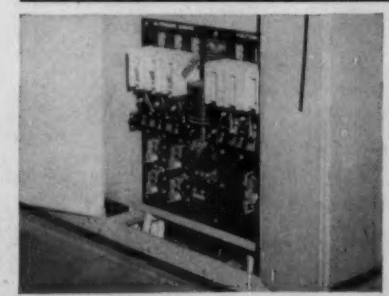
ASCO TRANSFER SWITCHES, specified in many other applications where power is vital, guarantee continuous power to such vital services as tunnel pumps, control rooms, and fire alarm systems. They feature these basic advantages of ASCO Transfer Switches:

• continuous duty rating in either normal or emergency position • capacity to withstand inrush currents 20 times full load rating • mechanical locking, providing sure contact pressure • single coil design • built-in time delay, so that equipment ignores harmless momentary outages • accessories to meet your specific requirements • full phase protection and other design features.

Write for Catalog 57-S2 on ASCO Remote Control Switches – for Booklet 596 describing how to select an adequate automatic transfer switch – or for Catalog 57-S1 on ASCO Automatic Transfer Switches.



Triple interlocked Bulletin 911-163S Remote Control Switches are used for switching the primaries of transformers feeding 800, 1000 and 1200 volt fluorescent lighting circuits.



Typical ASCO Bulletin 906-166 Automatic Transfer Switch provides auxiliary power for the circulating pump, the sewage ejector, the sump pump, the essential service bus and the control room.

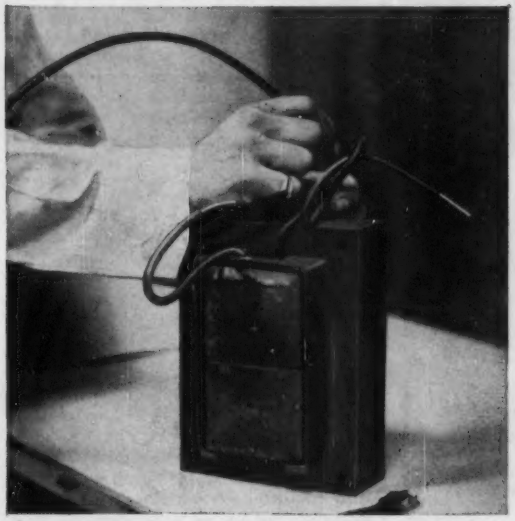
Automatic Switch Co.
50-K Hanover Road, Florham Park, New Jersey
FRontier 7-4600

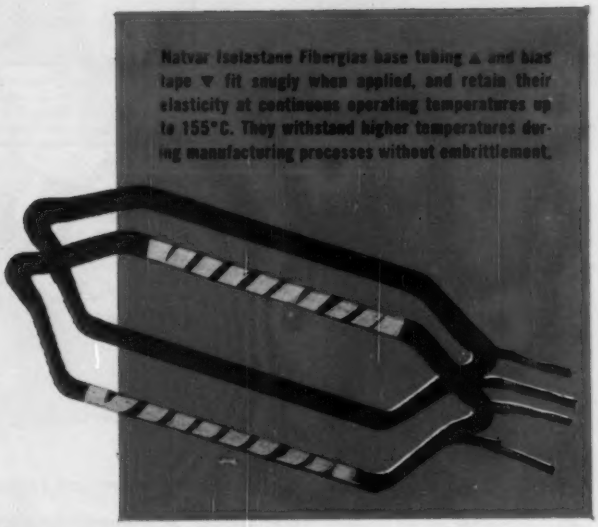
ASCO®

NATVAR ISOLASTANE* TUBING and TAPE

✓ **RESILIENT, ELASTIC** – for sharp bends and irregular surfaces

✓ **HEAT RESISTANT** —for continuous performance at temperatures up to 155°C





Natvar Isolastane Fiberglas base tubing ▲ and bias tape ▼ fit snugly when applied, and retain their elasticity at continuous operating temperatures up to 155°C. They withstand higher temperatures during manufacturing processes without embrittlement.

*ISOLASTANE *is Natvar's new elastomeric isocyanate type coating for Fiberglas braid and tape. Registration pending.*

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated—varnished tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 24

Natvar Isolastane is now making important savings possible. It makes it unnecessary to use expensive Class H materials to solve temperature problems during the manufacture of products which do not require Class H rating.

Isolastane is outstanding in its

- *ELASTICITY (EXTENSIBILITY)*
- *RESISTANCE TO HEAT*
- *RESISTANCE TO CRAZING AND CRACKING*
- *RESISTANCE TO SOLVENTS, INCLUDING THE ASKARELS*
- *TOUGHNESS AND ABRASION RESISTANCE*
- *WET DIELECTRIC STRENGTH*
- *LOW TEMPERATURE FLEXIBILITY*
- *FUNGISTATIC QUALITIES*

Full technical data and samples are available on request.

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE FULTON 8-8800 — CABLE ADDRESS NATVAR: RAHWAY, N. J.

203 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

Here's Why

GAI-TRONICS

Transistorized

COMMUNICATIONS

IS "TOPS"

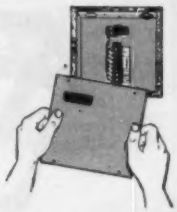
in *maintainability*

GTC

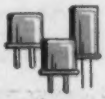
*an effective, economical industrial communication system designed to provide swift and sure voice communications regardless of distance or surrounding noise conditions.

1. Central control cabinet is eliminated.

2. Loudspeaker Amplifiers and Handset Stations are "plug-in". Untrained personnel can replace a defective unit with a "spare" in minutes. Repairs can be made at the shop bench.

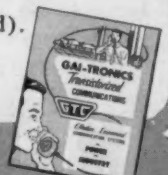


3. The inconvenience and expense of vacuum tube failure is completely eliminated. Unlike vacuum tubes, transistors indicate unlimited life and no deterioration in operation.



4. Because of transistors' much lower voltage requirements, GTC operates with much greater safety factor than vacuum tube equipment.

5. Ultra-simple wiring plan (no shielded cables used).



GAI-TRONICS
CORPORATION
Dept. B
READING, PENNA.

GAI FOUNDED 1936

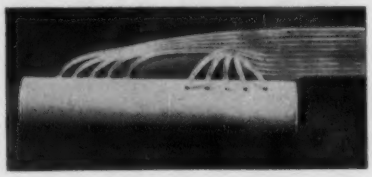
A SUBSIDIARY OF GILBERT ASSOCIATES, INC., ENGINEERS AND CONSULTANTS

GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet. It's yours free by return mail.

New Products

(*Continued from page 22A*)

Spectra-Tube. This item will bring neatness and ease of handling into the hook-up of banks of manometers in aerodynamic testing. Air operated controls, especially in multiunit installations, will be easier to install and service when the flat band of Spectra-Tube is used. Wires can be



threaded through to form heavy-duty, low-capacitance cable. Short lengths of Spectra-Tube can be located at intervals along a group of wires to form a serviceable air-spaced cable at low cost. Requests for information should be sent to John Ford, sales manager, Organic Development Corporation, P. O. Box 415, Garden Grove, Calif.

Little Snipper. A wire cutter based on new principles is proving ideal for work on switchboards and in crowded electronic chassis, and has already been adopted for assembly line and service work by several large companies. Called Little Snipper, the cutter features a radial shearing action, implemented through a spring-loaded thumb lever. For further information, write E. V. Nielsen, Inc., 575 Hope St., Stamford, Conn.

Tape Recorder with Electronic Remote Control. Remote electronic speed control, fully transistorized recording and playback modules, and a tape transport unit with dynamic braking make the new Mincom Model *C-100* instrumentation tape recorder completely versatile. No belts to change, and a total of 12 moving parts in the entire record-playback system insure reliability as well as ease of operation for the system, which handles from one to 14 tracks of simultaneous data. For further information contact Mincom Division, Minnesota Mining and Manufacturing Co., 2049 S. Barrington Ave., Los Angeles 25, Calif.

Transistorized X-Ray Detector. A portable protective device that warns against overexposure to X rays from high-power radar equipment and other high-voltage apparatus has been developed by the Universal Atomics Division, Universal Transistor Products Corp., 17 Brooklyn Ave., Westbury, L.I., N.Y. This new X ray detector, model *607-X* detects and measures X rays produced as secondary emission from high-power radar transmitters, magnetrons, klystrons, high-potential cathode-ray tubes, high-voltage scientific electronic equipment, and high-acceleration beam-type tubes.

(*Continued on page 42A*)

NATIONAL brushes cured this balky power shovel...and helped 14 other mines!

M. B. INMAN

Constant brush trouble on a power shovel led this mining company to call in "National" Carbon Brush Man M. B. Inman. His recommendation paid off so promptly he was asked to check recurring exhaust fan trouble at another company-mine.

Here Burt recommended brushes that could ride the fans' high speed commutators without burning. Next, the company asked Inman to survey all of its brush-using equipment. RESULT: a plan that simplified ordering, insured good performance and reduced inventories *by stopping duplicate ordering.*

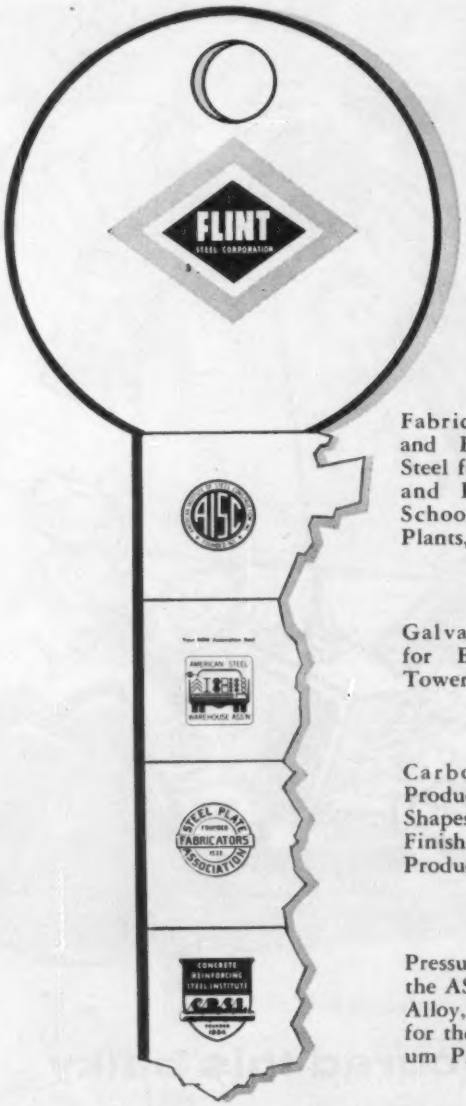
The "National" Brush Data Survey idea soon spread to every company-mine in the state... then to all mines in the neighboring state—15 mines in all. This is typical of the service provided by your "National" Brush Man. Call him today, or write National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

UNION CARBIDE

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.



Fabricated Structural Steel and Fabricated Reinforcing Steel for Bridges, Commercial and Industrial Buildings: Schools, Hospitals, Power Plants, Coal Washing Plants.

Galvanized Structural Steel for Electrical Transmission Towers and Substations.

Carbon Steel Warehouse Products: Structural and Bar Shapes, Plates, Hot and Cold Finished Bars, Construction Products.

Pressure Vessels fabricated to the ASME Code from Carbon, Alloy, and Alloy Clad Steels for the Chemical and Petroleum Processing Industries.

The key to successful bidding and a source for steel fabricated to your most exact specifications could be any one or all four of Flint's divisions —

Structural and Reinforcing —

Tower and Substation —

Fabricated Plate

and Steel Warehouse.

Structural steel can now be delivered promptly and when required.

for over 40 years

FLINT STEEL CORPORATION

TULSA . . . MEMPHIS

New Products

(Continued from page 40A)

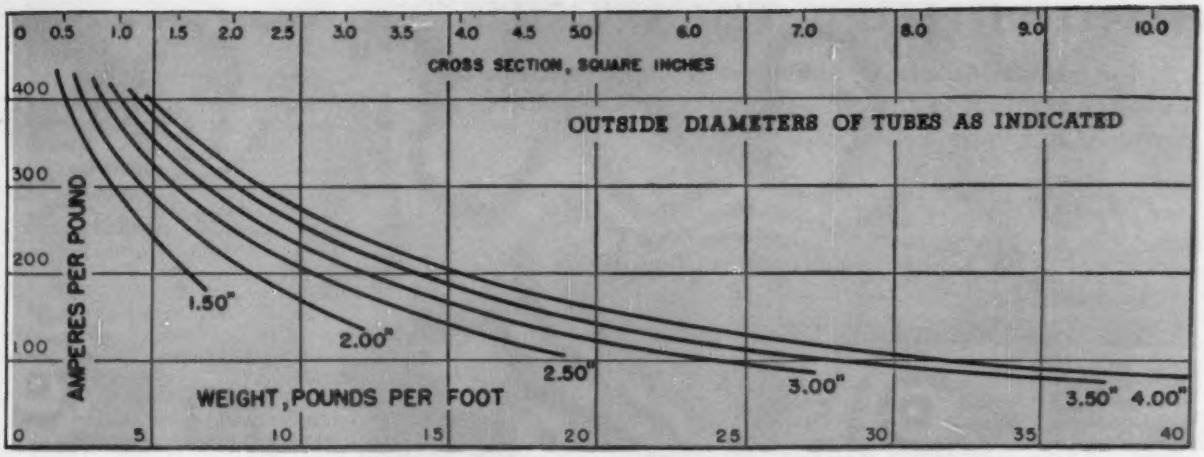
Graphite Lubricant Available in Bulk. Spray Graph, a multipurpose graphite lubricant that provides inert, dry-film lubrication for moving parts, valves, stoppers, regulators, switches, relays, etc., is now available in 1- and 5-gallon drums. Spray Graph provides chemically inert, fast-drying, long-lasting lubrication for metallic and nonmetallic surfaces. There is no surface build-up or drippage of the lubricant. It forms a heat- and friction-resistant film seconds after application. Spray Graph is manufactured and sold by the American Resin Corporation, 3215 N. Sheffield Ave., Chicago 13, Ill.

Battery Holders. A new line of unit cell battery holders for use in radios, phonographs, toys, and other electronic battery powered products has been made available. The battery holders are in the shape of a tube, and can hold two, three, or four *D* or *C* size dry cells of the flashlight type. This means that battery consuming equipment designers can use the holders for 3-, 4½-, or 6-volt applications and if desirable, two or more tubes can be used together for higher voltages. For further details on the unit cell battery holders, write Department 284, Mayfair Molded Products Corp., 3700 N. Rose St., Schiller Park, Ill.

Shatterproof Mirrors. These plastic mirrors provide important advantages whenever safety and permanence are factors for consideration. Made of Homalite *CR-39*, a thermosetting plastic, the mirrors have high impact strength and excellent scratch resistance, are resilient and lightweight, and will not shatter. Permanent silver backing applied to the plastic gives a clear, sharp, distortion-free reflection and will not oxidize or chip off. For information, write to The Homalite Corporation, 11-13 Brookside Dr., Wilmington 4, Del.

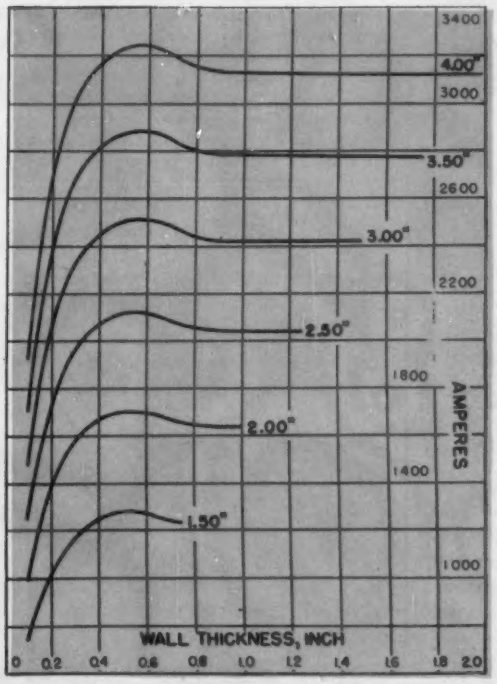
Fotoperiscope in New N-9 Accessories. A periscope attachment which permits "around-the-corner" photography with any 16 mm motion picture camera, is now available. It was developed to improve photographic coverage of cameras mounted in cramped missile and aircraft installations and it also eliminates frequent changes of camera location. Also developed is a new line of camera accessories, designed to extend the versatility, performance, and economy of the *N-9* gun camera. The *N-9*, long noted for its compactness and reliability, has been used for years in virtually every aircraft photo instrument laboratory in the United States. The systems package now has an improved 50-foot magazine, a 100-foot magazine, a twin-light timing system, a unique frame-event correlation device, and the Fotoperiscope lens assembly with 360° rotation. Use of these accessories will save time in film loading and unloading, camera mounting, changeovers, and evaluation and correlation of test results. For further information contact Traid Corporation, 17136 Ventura Blvd., Encino, Calif.

(Continued on page 44A)



60-CYCLE CURRENT ratings of six round copper tubes in terms of weight per foot.

How to carry more amperes per pound of copper



THE INFLUENCE of wall thickness on the 60-cycle current rating of six round copper tubes.

THIN-WALL TUBES with low wall-thickness-to-diameter ratio offer decided electrical advantages—and opportunities for cutting bus costs—wherever mechanical requirements permit. The charts above and at the left show the 60-cycle skin-effect phenomenon characteristic of six representative sizes of round copper tube, 1.5″ to 4.0″ O.D. The curves cover the entire range of wall thickness from solid round rods, at the right, to the thin-walled tubes in common use at the left. What is true of round tubes is also true of other tubular bus shapes.

INSTALLATION ECONOMIES. When round tubular bus conductors can be selected in thin-wall sizes from the standard pipe dimension schedules, it is possible to effect further economies by the use of stock sizes of supports, connectors, tap clamps, and other necessary hardware available in great variety in dealers' stocks.

More complete information on tubular conductors is available in the Sixth Edition of The American Brass Company's Publication C-25. This 62-page booklet has a wealth of general information on the properties of copper conductors—plus convenient data for the most commonly used sizes of all types of rigid bus conductors.

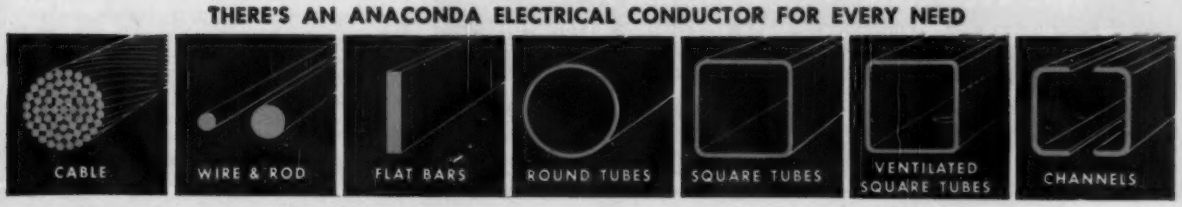
TECHNICAL SERVICES. Anaconda specialists are available to help you in the solution of technical problems involving the use of Anaconda Bus Conductors. For such service, or for a copy of Publication C-25, see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 87100

ANACONDA®

COPPER CONDUCTORS

Made by The American Brass Company

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



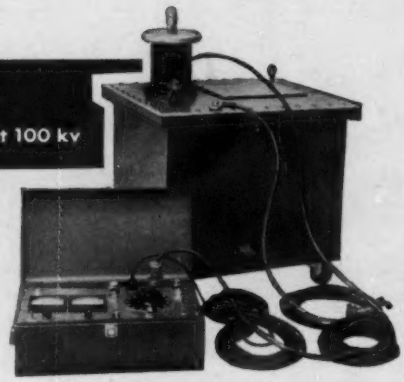
BIDDLE DIELECTRIC TEST EQUIPMENT

. . . for measuring direct current at voltages up to 100 kv when applied to the insulation of generators, transformers, bushings, cable, etc.

New

MODEL 2

current output 6 ma continuous at 100 kv



More and more engineers are leaning to d-c testing with voltages equal to or somewhat greater than equivalent peak alternating voltages. Their experience and increased knowledge and appreciation of the advantages of testing with direct voltage have accelerated the need for test equipment to meet field requirements.

IMPORTANT FEATURES

- Well-designed provisions for utmost safety
- Simple operation and reliable performance
- Excellent output voltage regulation
- Compact, mobile design
- Facilities for voltage and leakage current measurements

IMPORTANT APPLICATIONS

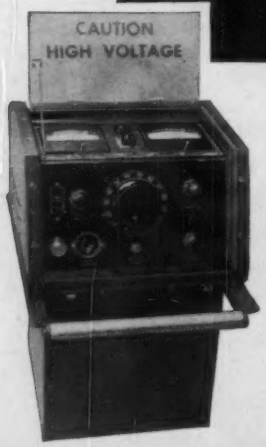
. . . in development . . . for testing the d-c dielectric strength of insulating materials and the adequacy of the electric design of insulation in any type of electrical equipment.

. . . in production . . . for non-destructively detecting defects in the insulation of electrical equipment due to design, material, and workmanship.

New

MODEL 1-A

3 ma continuous at 40 kv



. . . in maintenance . . . for non-destructively detecting unreliable condition of insulation of new or repaired electrical equipment. Preventive maintenance tests on important rotating equipment, cable, switchgear, etc., result in appreciable savings.

For important details regarding these units and information on the subject of high voltage d-c testing *write for our New Bulletin 22-EE.*

B-800

JAMES G. BIDDLE CO.

1316 ARCH STREET • PHILADELPHIA 7, PA.

ELECTRICAL TESTING INSTRUMENTS • SPEED MEASURING INSTRUMENTS
LABORATORY & SCIENTIFIC EQUIPMENT

James G. Biddle Co.
1316 Arch St., Phila. 7, Pa.
Please send me
BULLETIN 22-EE

Name_____
Company_____
Address_____
City_____ Zone____ State____

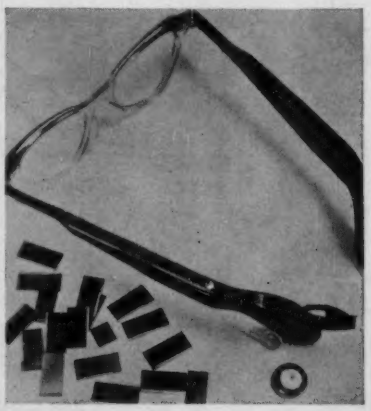
New Products

Continued from page 42A

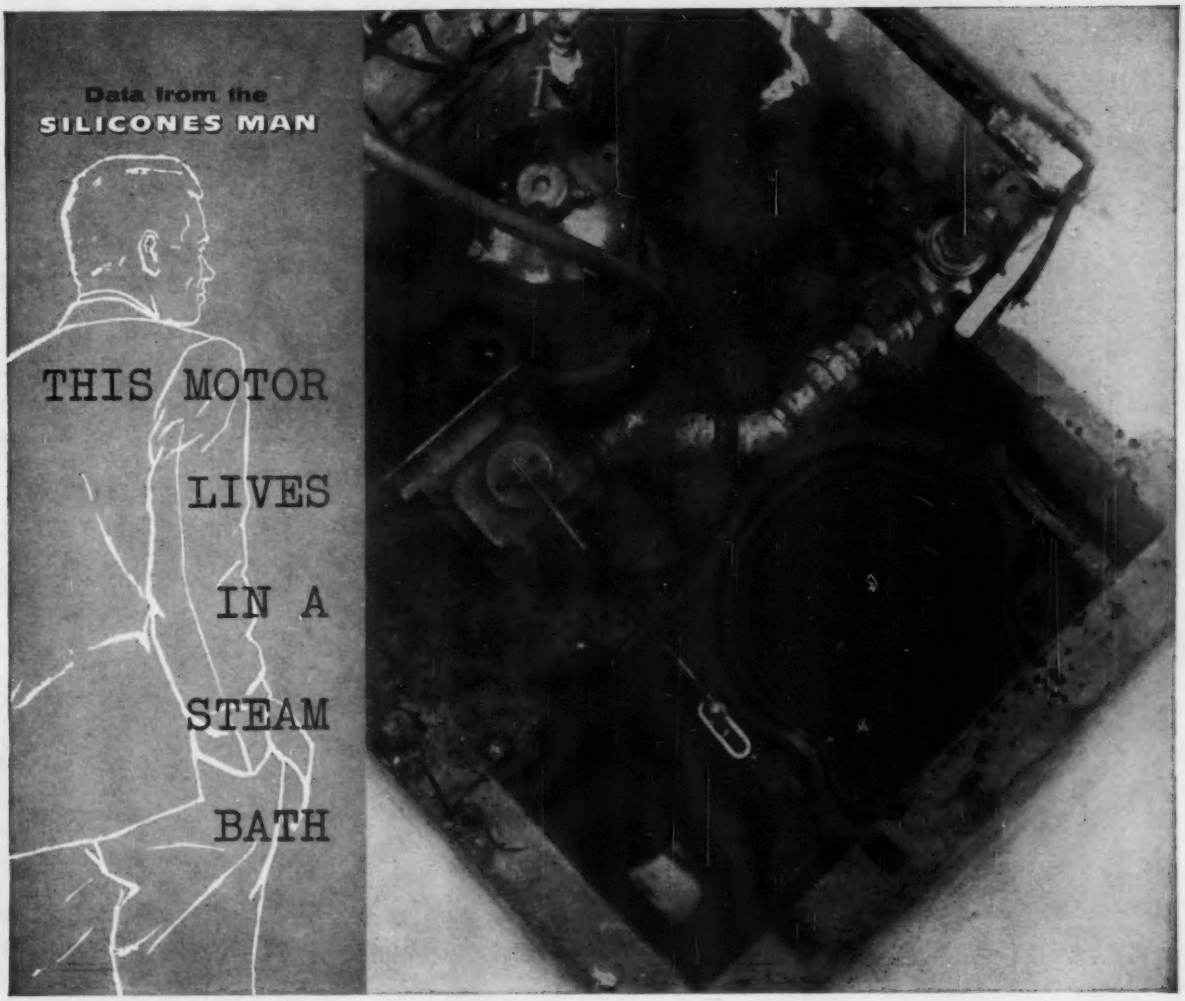
High Temperature Test Chamber. In the manufacture of guided missile systems, the need has been found for a test chamber to simulate elevated temperatures for testing hydraulic actuators. Grieve-Hendry Co., Inc. have developed a unit for this specialized requirement. This Test Chamber is especially built to minimize the possibility of accidental fire at above normal temperatures. A neutral atmosphere of nitrogen gas is maintained within the chamber at all times when temperatures are above room ambient. To maintain fireproof atmosphere, doors must be closed once the heating cycle has been started until the temperature of the chamber has been returned to room temperature. Full information may be had by writing Grieve-Hendry Co., Inc., 1401 W. Carroll Ave., Chicago 7, Ill.

New Regulator. An all-purpose two-stage regulator combining the best features of magnetic and electronic amplifiers has been developed by the Clark Controller Company, 1146 E. 152 St., Cleveland 10, Ohio. Special features are electrically isolated inputs, compactness, and minimization of drift. The regulator will be applied on adjustable-voltage d-c drives and other applications for voltage and current regulation in speed, tension, position, and similar systems. For further information contact the manufacturer.

Solar Cells in Hearing-aid Eyeglasses. A product utilizing silicon solar energy converters is the Zenith "Solaris" eyeglass-hearing aid. Miniature silicon cells convert sunlight and incandescent light into electrical energy which powers the hearing



aid. Excess energy from the sun is stored in regular mercury or a nickel-cadmium battery in the eyeglass temple bar. The cells are not affected by moisture, suffer no deterioration from atmospheric conditions, and have an indefinite extended lifetime. For further information contact the Hoffman Electronics Corporation, Semiconductor Division, 930 Pitner Ave., Evanston, Ill.



When water accumulates in an underground steam distribution system this pump goes to work. But during periods of heavy rain, the water rises and covers the pipes, giving off clouds of steam. Failures were frequent. Since rewinding to Class H specifications using UNION CARBIDE R-620 Silicone Insulating Resin, there has not been a single failure! Time and time again, where a motor is subjected to high temperatures, corrosion, overloads, or dirt, the answer has been found in Class H insulation.

You can easily give your rewind customers all the advantages of Class H insulation, because R-620 Silicone Insulating Varnish is as simple to use as ordinary varnishes. For example, at 450 deg. F., a Class H motor would cure in less time than a Class B motor of the same size at 300 deg. F. The time consuming step-by-step curing cycles required by earlier materials are eliminated.

UNION CARBIDE R-620 is easily adapted to your shop practice. You will find that it gives a hard, tough, yet flexible finish. The proper viscosity is built in, eliminating frequent solvent additions. No additional treatments are required to protect against moisture or corrosive atmospheres.

Find out more. Write for the booklets, "UNION CARBIDE Silicones for Dependable Service" and "More for your Silicones Dollar." Address Silicones Division, Box IE-6703, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

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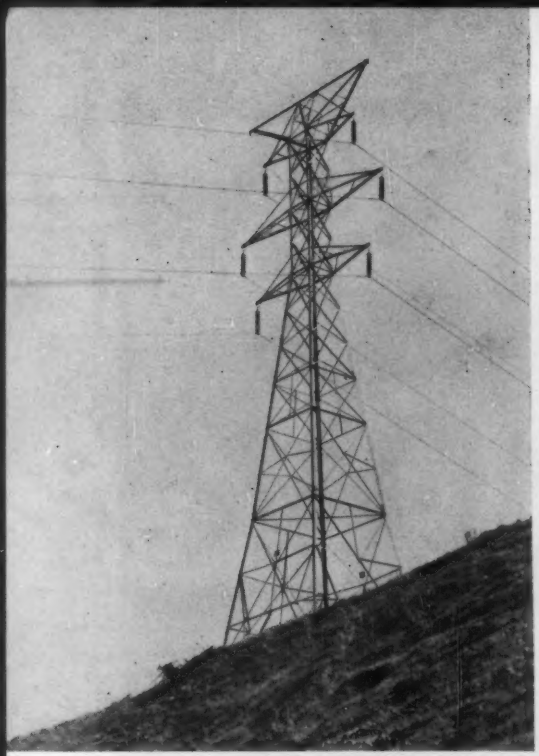
UNION CARBIDE
TRADE-MARK
SILICONES



Towers 2050′ apart

Specially designed towers solve tough location problems for Public Service Co. of Indiana, Inc. —a customer of American Bridge since 1940

Transmission towers on the hills near the New Albany generating plant.

support 4 tons of conductor!

To support 132 kv double-circuit transmission lines from its new power station at New Albany across 23.71 miles of countryside, the Public Service Company of Indiana, Inc. used 121 towers designed and fabricated by American Bridge. None of these towers are less than 100′; some are 110′ and 120′ tall.

In skirting the town of New Albany, it was necessary to go through a particularly rough and hilly section with elevation changes as great as 400′ and with distances between peaks ranging from 400′ to 2050′.

Since the line consisted of six high-voltage conductor wires, weighing an estimated 20,802 pounds per mile, those towers which were 2050′ apart had to be strong enough to safely support 4 tons. *And, when loaded with ice, the weight could be twice as heavy.*

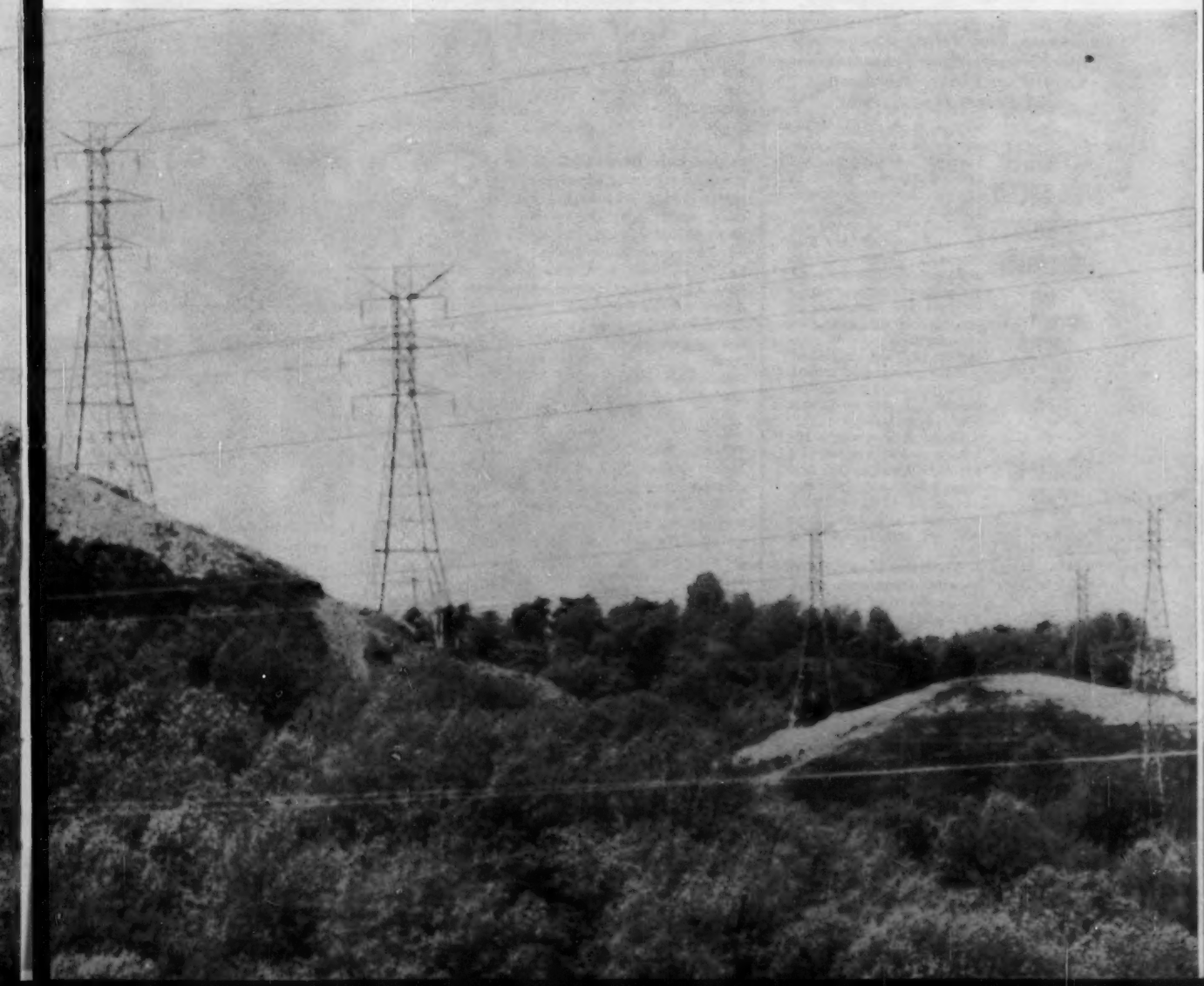
The Public Service Company of Indiana, Inc. has been a tower customer of American Bridge since 1940. This latest order is in recognition of the fine service received from the product itself, and the good relations which have existed between the companies.

For recommendations based on your specific requirements, just write our nearest office.

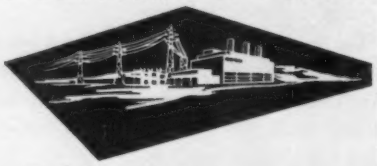
USS is a registered trademark

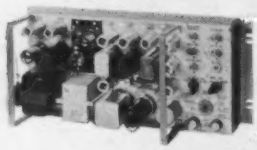
American Bridge Division of USS United States Steel

General Offices: 525 William Penn Place, Pittsburgh, Pennsylvania. Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York



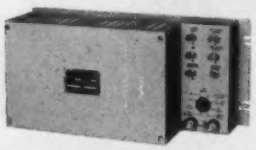
Telemeter
ANY VARIABLE
from Remote Points





MODEL 1025 Transmitter

MODEL 1090 Receiver



Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

•

Built-in Self-Calibrating Circuit

•

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU

Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

INDUSTRIAL NOTES

Color Alarm System. The Electro-Pane color sequence eliminates the need for a flasher. Although a flashing Electro-Pane is also available, preliminary tests have indicated the new color sequence provides for longer lamp life and still maintains excellent discrimination between alarm condition and acknowledged condition. The backlighted nameplate is bright white during alarm condition. Pushbutton acknowledgement changes it to red. Upon clearance it changes to green or the nameplate can be automatically reset. Audible signals appear with the white and green colors. Any sequence of colors can be substituted in the standard unit. Continuous filament monitoring is provided eliminating the necessity of pushbutton lamp test. For further information contact Electro Devices Incorporated, 116 S. Michigan Ave., Chicago 3, Ill.

Relocation. The A. V. Smith Engineering Company has moved into the recently completed Essex Building, Narberth, Pa. The latest engineering and architectural designs were employed with provisions for planned expansion in 1960. The ground floor contains laboratories, field instrument maintenance, repair and storage facilities, and a shop area. The main floor contains offices, drafting room, and library.

Central Tape Data Library. Completion of a central tape data library which will store tape-recorded information and automatically search 3,000 items and play back seven simultaneously, has been announced by Electronic Engineering Company of California, 1601 E. Chestnut Ave., Santa Ana, Calif. The system, which was designed for the Air Force, is a push-button "Library of Congress" tape system for the storage and location of magnetic tape recorded data. The system will store 3,048 2-minute segments of recorded information.

Whisker Wires for Semiconductors. Secon Metals Corporation, development and production metallurgists, 7 Intervale St., White Plains, N. Y., have perfected fine whisker wires for semiconductor devices. Using their extensive experience in supplying highly engineered wire for the electronics industry, they are able to keep close control on the physical characteristics of the wire and to supply metals and alloys which are free of trace contaminants so harmful to semiconductor devices. They are able to produce the extremely difficult 1% antimony-gold alloy as well as to hold close elongation tolerances on the difficult 2% gallium-gold alloy.

Subsidiary Formed. The formation of Genesys Corporation, a wholly owned subsidiary specializing in the field of electronics, has been announced by Chance Vought Aircraft, Incorporated, Dallas, Tex. Operating as a general systems and products company, Genesys Corporation will specialize in the design, development, and manufacture of advanced control computer systems, components, and allied products. Major emphasis will be on commercial and industrial applications. The new corporation is located at 10131 National Blvd., Los Angeles, Calif.

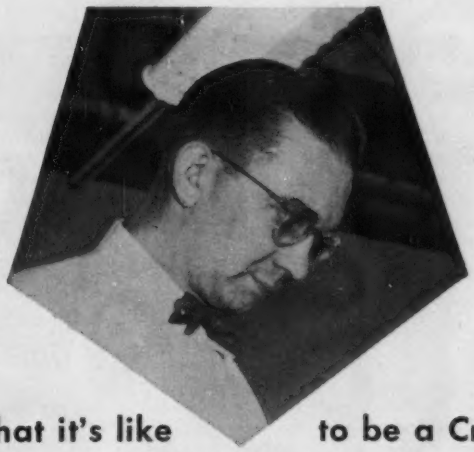
A Porcelain-to-Aluminum Seal. Westinghouse Electric ceramic materials engineers have devised a method for sealing aluminum to high-tension electrical porcelain. This method requires no intermediate materials and no costly vacuum or atmosphere heat treatments. A mechanically reliable, vacuum-tight seal reseults in bringing high-purity aluminum and porcelain or other alumina-silica ceramics into

Courtesy Westinghouse

contact with one another under carefully controlled temperature and temperature-change conditions. Although still a laboratory development, the new seals can be used in transformers, circuit breakers, and capacitors where the substitution of aluminum for steel or other structural materials is desirable. For further information contact Westinghouse Electric Corporation, Box 2278, Pittsburgh, Pa.

AMF Government Products Group. American Machine & Foundry Company, 261 Madison Ave., New York 16, N.Y., has organized a government products group which consolidates its defense products group and Central Engineering Division. The government products group, under the direction of F. K. Powell, Jr., vice-president and group executive, consists of the Electro-Mechanical and Associated Missile Products Divisions. The new group will work on such projects as missile handling and launching systems, radar and electronics, automatic process machinery, automation of military weapons, armament, instrumentation and controls, structural dynamics, and silver-zinc batteries for guided missiles.

(Continued on page 59A)



INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

What it's like to be a Creative Engineer at IBM

"Inertial guidance," explains John Prikazsky, "means aerial navigation without recourse to external reference. As an inertial guidance engineer with IBM, I have the opportunity to work on completely integrated bombing-radar-navigational systems. My work is broad — from lab studies to the analytics involved in system design—everything from shooting the North Star to heat transfer problems. That's why I like it — plus the chance I have to take on as much responsibility as I can handle."

Other challenging assignments at IBM Owego

- **Airborne analog and digital computer systems**
- **Units and systems**
- **Test equipment development**
- **Radar circuits and systems**
- **Transistor circuit design**

Qualifications

B.S. or M.S. degree in electrical or mechanical engineering, physics, or mathematics, and

Proven ability to assume a high degree of technical responsibility in your sphere of interest.

FOR DETAILS, just write, outlining background and interests, to:

Mr. P. E. Strohm, Dept. 550U
Military Products Division
International Business Machines Corp.
Owego, New York

IBM, a recognized leader in the electronic computer field, offers a stable balance of military and commercial work. You will find ground-floor opportunities for professional achievement at IBM Owego. Liberal company benefits set standards for industry today, and salaries are commensurate with your abilities and experience.

IBM MILITARY PRODUCTS

DATA PROCESSING
ELECTRIC TYPEWRITERS
MILITARY PRODUCTS
SPECIAL ENG'G. PRODUCTS
SUPPLIES
TIME EQUIPMENT

Plants and laboratories: Endicott, Kingston, Owego, Poughkeepsie, Yorktown, N. Y.; Lexington, Ky.; Rochester, Minn.; San Jose, Calif.

Underground distribution system savings begin the day you decide to install J-M Transite Ducts. You can figure on lower operating costs, prolonged insulation life, more reliable service and longer cable life.

J-M Transite Ducts permanently resist fire and arc... provide lifelong dependability, many operating economies

GONE ARE MANY of the headaches of transmitting heavy electrical loads underground, when you protect cables with Johns-Manville Transite® Ducts. They assure you of greatest protective value, and maximum load capacity, per dollar invested.

And when cable fire or failure occurs, noncombustible Transite Ducts remain undamaged and can be used again for the new lines. Regardless of conditions, Transite Ducts provide permanent service as they do not deteriorate from heat, water or corrosive soils.

Tests have shown that Transite-protected cables run cooler under given loads . . . carry greater loads at given temperatures because Transite helps dissipate heat faster. And for lower operating costs, consider the long-range value of Transite Ducts in terms of (1) increased insulation life, (2) fewer cable failures, and (3) lower I^2R losses for the full working life of a system.

For details on Transite Ducts' many advantages, distribution engineers are invited to write for informative brochure EL-29A. Johns-Manville, Box 14, New York 16, N.Y. In Canada, 565 Lakeshore Road East, Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

ANATHERM can be used at any hottest-spot temperature over the range of 105°C to 155°C. It can save you money . . . and save you space.

More horsepower per pound–it's yours with 155°C Anatherm

First polyester high temperature enamel magnet wire available in complete range of sizes—round, square, rectangular.

Of course you don't fry eggs on them, but motors are being run hotter today. These higher operating temperatures can put you on a *hot spot* with your customers—if motors fail.

Solution: Anaconda Anatherm Magnet Wire. Anatherm is a new polyester film-coated wire—fully tested for use at "hottest spot" temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted 155°C (AIEE Class F) rating!

Greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength—make Anatherm ideally suited for a variety of applications. It's especially practical where maximum performance and reliability are required from smaller equipment operating at higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot temperature from 105°C to 155°C.

Available in standard film-thickness of round wires, sizes 8 to 46, inclusive, and in a full range of sizes of square and rectangular wires. For more information, see the Man from Anaconda. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Co., 25 Broadway, N. Y. 4, N. Y.

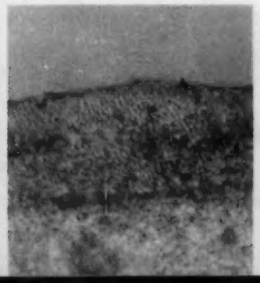
SSM1

ASK THE MAN FROM ANACONDA® *ABOUT* **ANATHERM MAGNET WIRE**

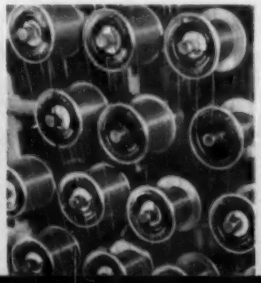
For you, Anatherm can mean smaller electrical equipment... higher operating temperatures. See details on reverse side—

ANALAC 105°C (AIEE Class A) solderable magnet wire

VITROTEX 130°C (AIEE Class B) glass-insulated, high heat resistance



PLAIN ENAMEL 105°C (AIEE Class A) low-cost enameled magnet wire



NYFORM 105°C (AIEE Class A) superior windability

EPOXY 130°C (AIEE Class B) general compatibility

MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm's higher 155° C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection . . . longer equipment life . . . wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

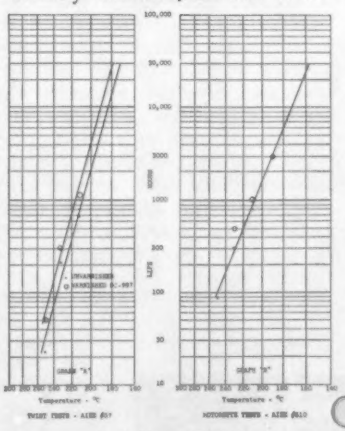
Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.



Valuable Anatherm Magnet Wire Handbook—
yours for the asking!
Latest information . . . full technical data.

ANACONDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send me a copy of your Anatherm Magnet Wire Booklet.

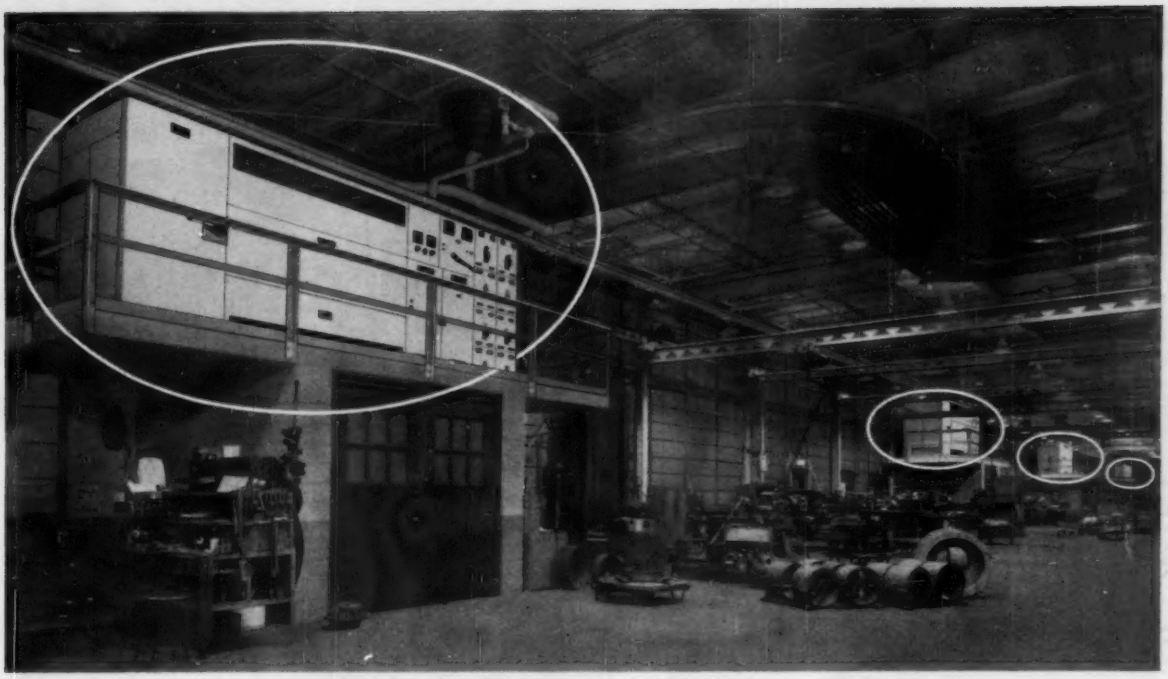
NAME & TITLE.....

COMPANY.....

ADDRESS.....

CITY.....ZONE.....STATE.....

TEAR OUT FOR YOUR FILE



Another important installation of SORGEL dry-type transformers and substations

This time in the modern LOUIS ALLIS plant in Milwaukee where the renowned motors are built

In this newest addition to the Louis Allis plant, the economy of high voltage efficient distribution was achieved with 13,200 volt distribution to three 1000 Kva and one 500 Kva substations, installed at various load centers.

These substations, equipped with SORGEL dry-type transformers, are so compact that they could be installed on balconies, thus gaining more floor space available for production.

This installation saved the Louis Allis Co. thousands of dollars over a low voltage distribution system, and provided them with the efficiency that only a high voltage distribution can provide.

Again the ingenuity of the principals and engineers, combined with SORGEL expert engineering, resulted in a most modern, flexible, space-saving and efficient electric distribution system.

Consulting Engineers — Klug & Smith Co.
Electrical Contractors — Uihlein Electric Co.

Electrical manufacturers are in a position to judge the quality of electrical equipment — that is why so many use SORGEL dry-type transformers in their plants and with their product.

These quiet SORGEL dry-type or Askarel-cooled transformers are available with any make or type of switchgear, and from any switchboard manufacturer in all ratings up to 10,000 Kva and 15,000 volts.

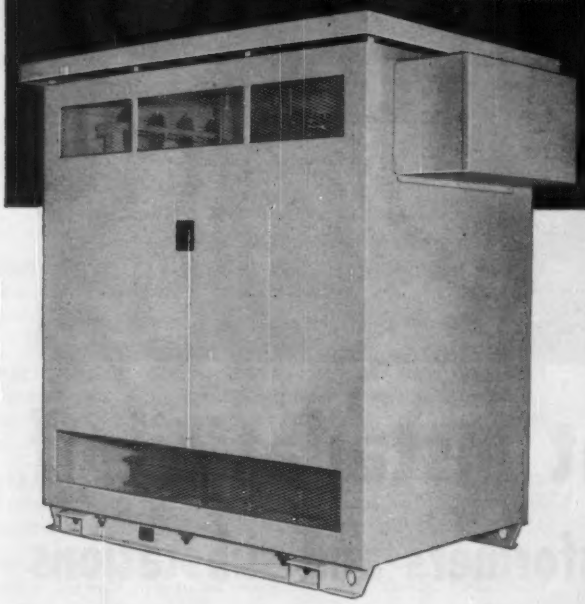
Sales engineers in principal cities.
Consult the classified section of your telephone directory or communicate with our factory.

SORGEL DRY-TYPE Transformers

40 years' experience in the development, manufacturing and application of transformers.

SORGEL ELECTRIC CO., 846 West National Avenue, Milwaukee 4, Wisconsin

Quick Delivery on SPECIAL TRANSFORMERS AND LOAD DISTRIBUTION CENTERS



When you need transformers with special voltage ratings, special taps or special accessory switch gear, send the specifications of your requirements to Acme Electric.

Our facilities for producing "Special Transformers" often permits us to make shipments months ahead of usual delivery schedules.

We can "ship from stock" most popular size standard transformers. Special ratings from 1/10th to 225 KVA, single phase, and 9 KVA to 750 KVA, 3 phase, shipped promptly. When you need dry type power or distribution transformers in a hurry—write or wire.

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229 WATER STREET • CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

In the field, at the job or in the office

PLAN HOLD
CADDY RACK

with folding table

Efficient vertical file and mobile conveyance all in one. Holds 1200 prints, plans, maps, other large sheets... organized for instant identification and use. Sheets can't get mislaid or lost... no folding, rolling or stacking.

PLAN HOLD Vertical Files, Binders, Cabinets and Racks are distributed internationally. See them at your engineering and office supply dealer or write for Catalog 585 to Plan Hold Corp., South Gate, California.

COMPUTER ENGINEERS

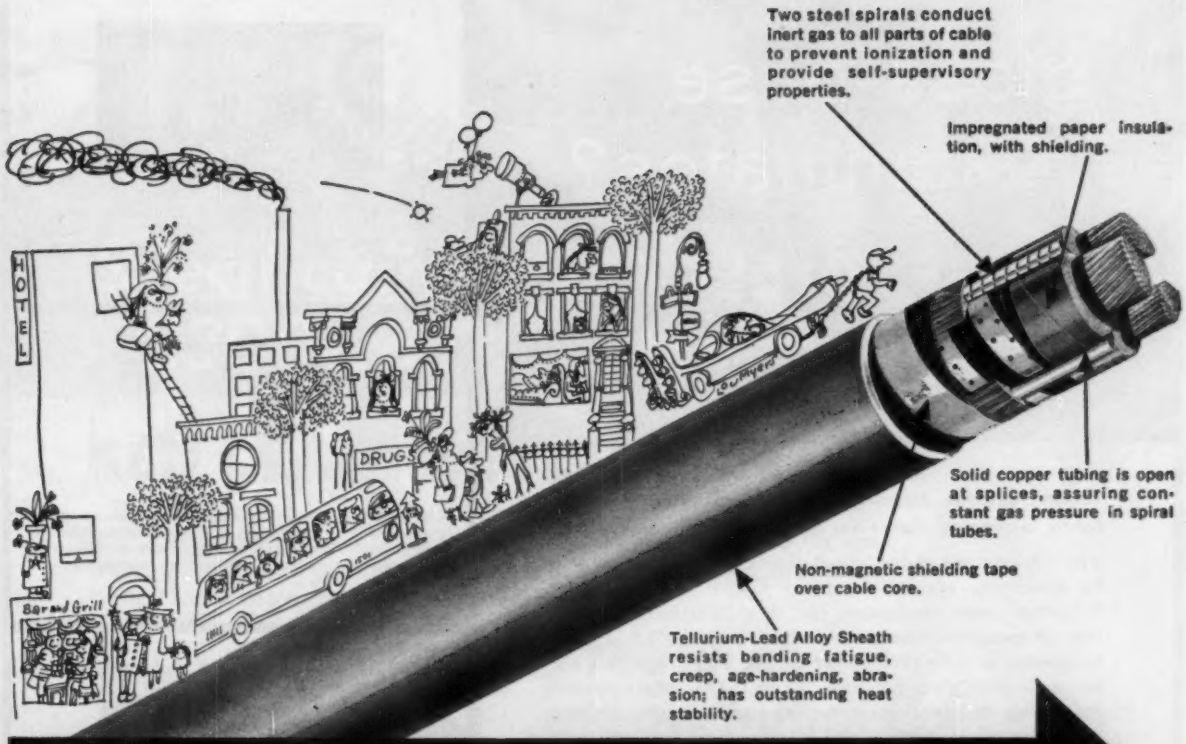
Several Computer Engineers are required to service a large scale, parallel mode, binary digital computer with buffered magnetic tape input-output. Applicants must have above average understanding of electronic circuits and a Bachelor's degree in Electrical Engineering or equivalent practical experience.

This is a permanent position with a leading research center and offers a challenging opportunity to qualified personnel. Receive an excellent salary and outstanding employee benefits, and enjoy stimulating staff associations.

If you possess an exceptional background in the area described, send a complete resume to:

A. J. Panerai

ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th St.
Chicago, Illinois


Two steel spirals conduct inert gas to all parts of cable to prevent ionization and provide self-supervisory properties.
Impregnated paper insulation, with shielding.
Solid copper tubing is open at splices, assuring constant gas pressure in spiral tubes.
Non-magnetic shielding tape over cable core.
Tellurium-Lead Alloy Sheath resists bending fatigue, creep, age-hardening, abrasion; has outstanding heat stability.
HOTEL
DRUGS
Bar and Grill

KEEPS UPHILL POWER "ON THE LEVEL"!

ROEBLING
GAS-FILLED CABLE

What happens when solid-type cable is used on steep grades? If you've used it, you know! The oil impregnant simply obeys the law of gravity and drains to the bottom of the grade. At the low point, hoop stress (caused by oil pressure build-up) makes the lead sheath stretch. Eventually a rupture occurs. And in the areas drained of oil, ionization takes place.

What's the answer to this constant (and inevitable) problem? *Roebling Low-Pressure Gas-Filled Cable*—for voltages up to 46 kv! Dry nitrogen gas, inside this cable at approximately 12 psi pressure, provides consistent dielectric properties throughout the length of the cable. No matter how steep the grade, internal pressure is uniform everywhere.

Another feature of this cable is that it is self-supervisory—an alarm system lets you know if there's trouble along the line.

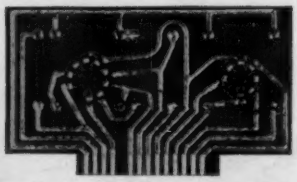
Roebling Low-Pressure Gas-Filled Cable is as easy to splice as solid-type paper power cable. It offers the least expensive long-term answer to the problem of transmitting power uphill! Get the whole story from your Roebling Field Representative soon. Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

ROEBLING

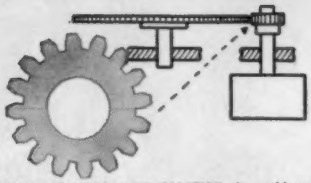
Branch Offices in Principal Cities • Subsidiary of The Colorado Fuel and Iron Corporation

glass-base laminates?

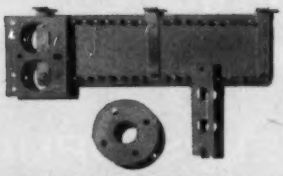
C-D-F DILECTO®
is the answer!



SPEED AUTOMATIC PRODUCTION of printed circuits with warp-resistant C-D-F metal-clad Teflon* and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.



HIGH-VOLTAGE (1800v.) RF ISOLATION is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.



PRECISE MACHINING AND FABRICATION are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

Teflon*, silicone, epoxy, melamine, and phenolic glass-fabric laminates. Polyester glass-mat laminates.

You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN

PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES

Grade	Equivalent NEMA or ASTM grade	Flexural Strength Lengthwise (PSI)	Dissipation Factor at 10^{6} Cond. A	Dielectric Strength Parallel Step x step	Insulation Resistance Cond. C96/35/90	Arc Resistance (seconds)	Maximum Operating Temp. (°C.)
GB-112T (Teflon*)	None	14,000	0.0015	65	100,000	180 +	250
GB-12S (Silicone)	G-7	28,000	0.002	60	100,000	180+	200
GB-28E (Epoxy)	G-10	70,000	0.019	65	75,000	130	150
GB-28EFR (Flame-Retardant Epoxy)	G-10	68,000	0.010	65	100,000	180	150
GB-28M (Melamine)	G-5	50,000	0.014	50	100	185	135
GB-261D (Phenolic)	G-1 and G-2	22,000	0.020	55	10,000	5	150
GM-PE (Polyester)	GPO-1	35,000	0.020	70	200	130	150

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

CDF

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Bexel COMPANY • NEWARK 86, DELAWARE

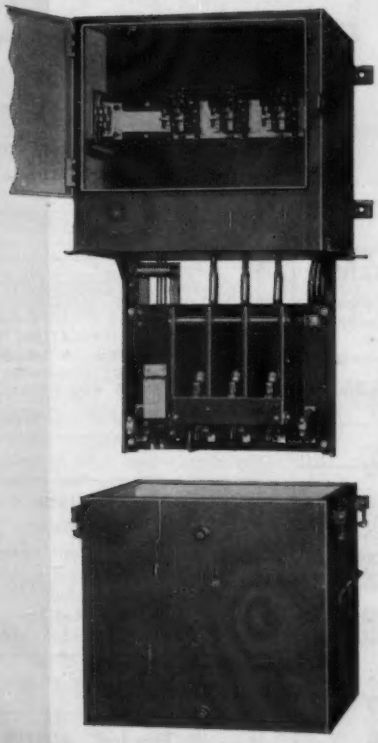
Designed

Specifically for 2300-volt Motors –

NEW EC&M type LZH STARTER

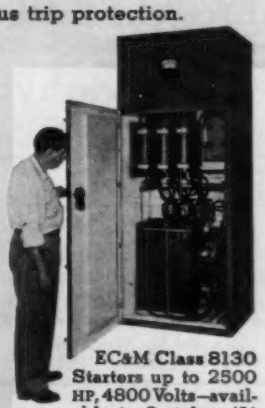
This new starter is compact, lower in cost than EC&M's Type ZHS high capacity oil-break starters, and is especially designed for use where short circuit requirements are small or where high interrupting protection is provided by other means.

You Get these BIG features – at Low Initial Cost



- **Wide application—up to 350 HP at 2300 volts. Interrupting capacity 10x full load motor current.**
- **Self-contained Control Transformer with fused secondary for 220-volt pushbutton operation.**
- **Type ZTM thermal-magnetic overload relays give inverse time and instantaneous trip protection.**
- **Heavy-duty Type LZH magnetic contactor.**
- **Wall-mounted with drop oil tank. Anti-syphon leads between tank and upper compartment.**
- **Control leads brought to terminal board. Incoming and outgoing cables equipped with solderless power lugs.**
- **High and low voltage separated by insulating barrier.**

***Write* for Bulletin 8121**



ECaM Class 8130 Starters up to 2500 HP, 4800 Volts—available in 3 styles: *(1)* 50,000 KVA *(2)* Power Fused and *(3)* VALIMITOR (unlimited protection without fuses)

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
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The J. G. WHITE
Engineering Corporation
Design—Construction—Reports—Appraisals
80 Broad Street NEW YORK

Industrial Notes

(Continued from page 48A)

Processing Facilities Acquired. The Lindberg Steel Treating Company announces the acquisition of the processing facilities of the flame hardening department of the Metal Improvement Company, Los Angeles, Calif. These have been integrated into the selective heating Division of Lindberg's Los Angeles Branch located at 2910 S. Sunol Dr., and will provide additional productive capacity for selective heating services by the oxy-acetylene method. The acquisition also supplements the electrical induction heating and other metallurgical services.

Plant Addition. Ground has been broken for a new addition to the General Radio West Concord plant. Located at 275 Massachusetts Ave., the Cambridge property consists of 145,000 square feet of office, manufacturing, and storage space, in addition to 10,400 square feet of garage space and 41,400 square feet of parking space.

Steel Fabricating Facility. Construction work has been completed on the new $2 million Flint Steel Corporation plant in Tulsa, Okla. Now in full production, the plant is situated in the center of a 40-acre site at 2440 S. Yukon, in the Frisco Railway Cherokee Industrial District in

Hopkins Photography Co.

the west Tulsa area. The new fabricating facility includes a total of 364,000 square feet under one roof, or about 8½ acres. Also included is a 20,000-square-foot office building of modern functional design. The new building of Flint consolidates all of its Tulsa operations at one location.

Insulating Tape Wrapping Device. An improved device for wrapping insulating tapes on wire and cable has been developed by the assistant plant engineer of Rome Cable Corporation, Rome, N. Y. Paper, cotton, Fiberglas, or any combination of the three tapes can be applied with the new model, say company engineers. According to the inventor, D. L. Williams, the device cuts down machine vibration, a cause of insulation breakage during production runs. The tension of the tape being wound can be adjusted while the machine is in operation. This was not possible with the older apparatus. A more uniform wrapping can now be accomplished resulting in a superior magnet wire product.

(Continued on page 60A)

BUS BAR CONNECTIONS

COPPER OR ALUMINUM

Cadweld Connections on Copper or Aluminum Bus Bar Offer 5 Major Advantages

1. Random length bus can be used — reduces original material cost.
2. Weld size permits stacking of multiple runs, while maintaining proper spacing.
3. Reduced labor — individual fabrication of multiple runs permits easy handling of lightweight single sections.
4. Connections are permanent — not subject to loosening, corrosion or overload damage.
5. Newest CADWELD A-22 Aluminum welding alloy permits welding of transition joints of copper to aluminum.

CADWELD®

Erico Products, Inc.

2070 E. 61st Place Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario

POSITIVE
TIME-DELAY PROTECTION

Shawmut "t-d" Renewables have the best time delay characteristics of any renewable fuse. The t-d link gives maximum time delay protection in the higher current ranges as well as in the overload zone. Short-circuit operation is instantaneous, along with a reduction in the rate of rise of recovery voltage. The t-d link notches blow one after the other with rheostat-like action.

HIGH QUALITY - LOW COST

Precision-made. No soldered, welded or steel parts. Simple, sturdy, dependable. Easy to install, take apart or renew. Interchangeable links, renewable parts. Large silver-plated contacts. Adequate 2-way venting.

COMPLETELY RENEWABLE
FUSE OR LINK

Complete fuses and/or renewal links are available for either 250 or 600 V circuits; in ferrule ratings, from 0-60 Amps.; in knife-blade ratings, from 70 to 600 Amps.

Order now or ask for t-d Bulletin 500

*U.S. Patent No. 2,560,138 © The Chase Shawmut Co. 1958

t-d - "Awake At The Switch"

THE CHASE-SHAWMUT CO.

374 MERRIMAC STREET • NEWBURYPORT, MASSACHUSETTS

Subsidiary of I-T-E CIRCUIT BREAKER CO., Philadelphia, Pennsylvania

Amp-trap® Tri-onic® t-d® C-O-T® TRIONET® ONE O-T TIME

Industrial Notes

(*Continued from page 59A*)

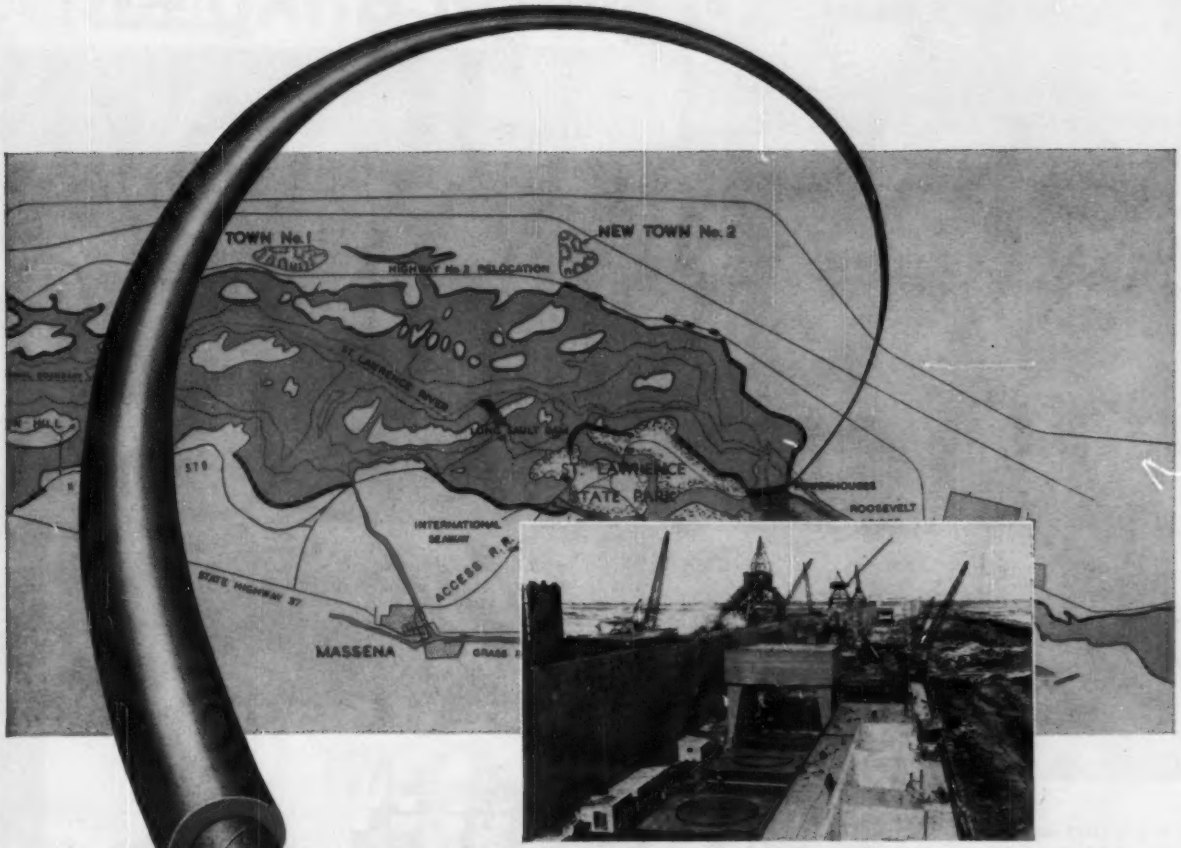
Nuclear Furnace Check. An electronic device which uses nuclear energy to "peer" through the hot walls of foundry furnaces to keep a constant automatic check on the level of material inside, has been developed by Nuclear Corp. of America, 400 Park Ave., New York, N.Y. Whiting Corp., Harvey, Ill., manufacturers of heavy industrial equipment are exclusive sales agent to the foundry trade for the new unit. Called the Indicon *I-100*, the device projects gamma rays through the furnace to two Geiger counters, one mounted at the maximum fill level, and the other at the minimum level. All components are outside the furnace, so the instrument is safe from corrosion and mechanical damage. Its signal can be harnessed to actuate automatic furnace controls, or it can register on a control board hundreds of feet from the furnace if desired.

RCA To Reduce Air Hazards. An automatic air-ground communications system designed to cut air traffic delays and help solve the problem of midair collisions will be developed by the Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N.Y., under a contract awarded by the Airways Modernization Board, which calls for production of experimental equipment capable of obtaining flight information by electronic means from up to 500 aircraft in 2 minutes. This is 25 to 50 times the present voice-channel capacity.

Safety through Efficient Communications. The new Northern Illinois Toll Road is to be protected by the same type of reliable 2-way voice communication and signaling system which has been a major factor in the safety records of such high-speed thoroughfares as the New Jersey, Ohio, and Indiana Turnpikes. RCA Telecommunication Division, the prime contractor for the microwave communication facilities on the Northern Illinois Toll Road, has designed a complete communications network, comprised of 22 stations, completely independent of any existing public systems. An integral part of this communication system is multiplex equipment furnished by Stromberg-Carlson, a Division of General Dynamics Corporation, Rochester 3, N. Y. This equipment, the *511* Multiplex, provides maximum flexibility in application to both voice frequency and tone signaling requirements, transmitting any desired combination of signals such as telephone, teletype, and facsimile directly by point-to-point radio. The units employ frequency division, single sideband, suppressed carrier techniques for a more economical use of available frequencies. The basic group of 10 channels, occupying the 4- to 44-kc portion of the frequency spectrum, may be expanded through the use of translators to any number of channels up to 170 within a minimum baseband requirement of 900 kc.

(*Continued on page 64A*)

Another call for Collyer . . .



St. Lawrence Project: Map and Photograph courtesy of the Power Authority of the State of New York. Project Engineers: Uhl, Hall & Rich, Boston, Mass., and Massena, N. Y.

At the St. Lawrence Power Project . . . COLLYER CONTROL CABLE

Style RR with RH-RW Insulation

THE VAST ENERGY POTENTIAL of the mighty St. Lawrence River is being harnessed in a power project of tremendous proportions, a joint effort of the Power Authority of the State of New York and the Hydro-Electric Power Commission of Ontario.

This multi-million dollar project is a monument to man's imagination, engineering genius, and peaceful cooperation. Collyer is proud to have been selected to supply the control cable which is to be used in the production, regulation and distribution of the tremendous quantities of electric energy which will be produced here.

MANY OF THE CONDUIT RUNS, although encased in concrete, are subject to adverse moisture conditions. The good aging characteristics of Collyer RR Control Cable (similar to Collyer C-101) with RH-RW insulation and neoprene-jacketed conductors, and the ability of Collyer RR Control Cable to meet the high engineering standards required on this job led to its selection for this vital service.

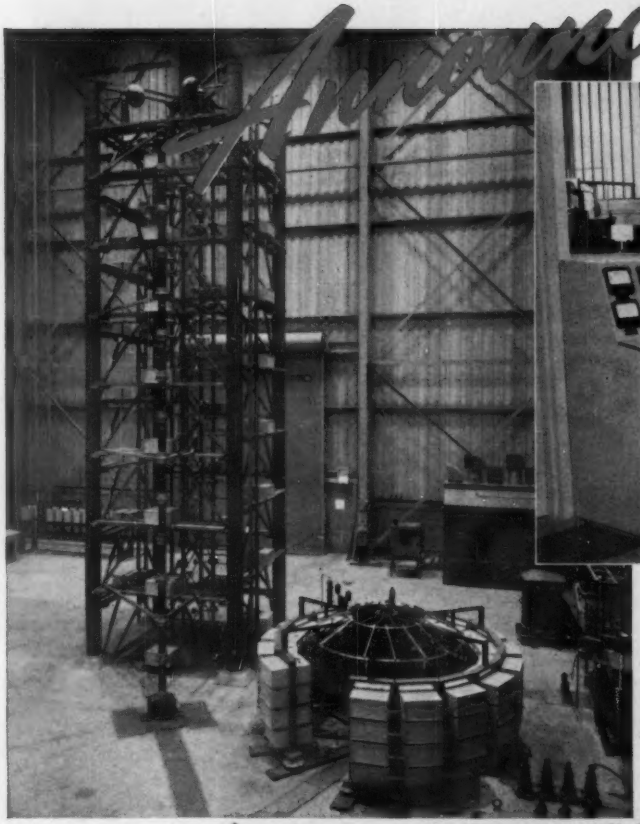
WHEN SEVERE ENVIRONMENTAL CONDITIONS require long-life, maximum service Control Cable, more and more engineers and contractors "Call for Collyer." Let us quote on your specific requirements. Write **Collyer Insulated Wire Co., 243 Roosevelt Ave., Pawtucket, Rhode Island.**

LIVE BETTER ELECTRICALLY

Collyer

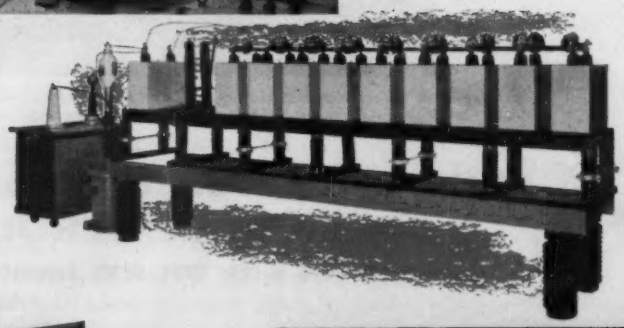
Power Cables • Control Cables
Switchboard Wires • Service Cables
Series Lighting Cables • Building Wires

Announcing ... NEW



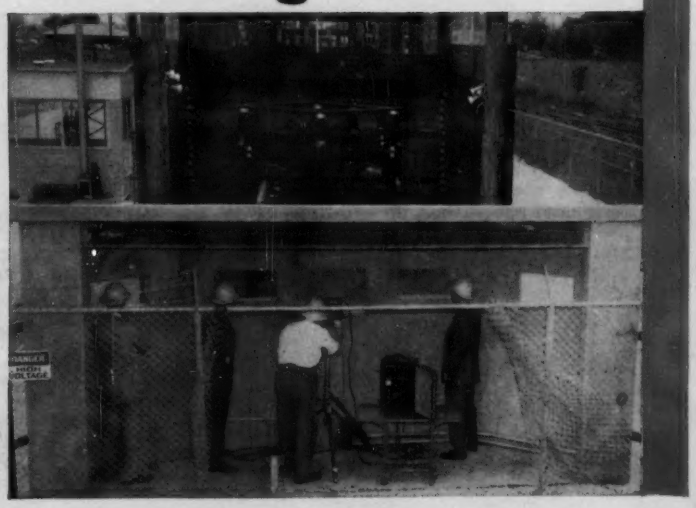
Nerve center of the laboratory—this master console permits control of all major equipment in both the outdoor and the indoor laboratory. Unique instrumentation includes interlocking controls, high speed recording devices for diverse, precise testing.

Here a 3,200,000 volt surge generator—powerful enough to spark over a 17 foot gap—simulates lightning effects on electrical equipment. High surge current generator is seen in the foreground.



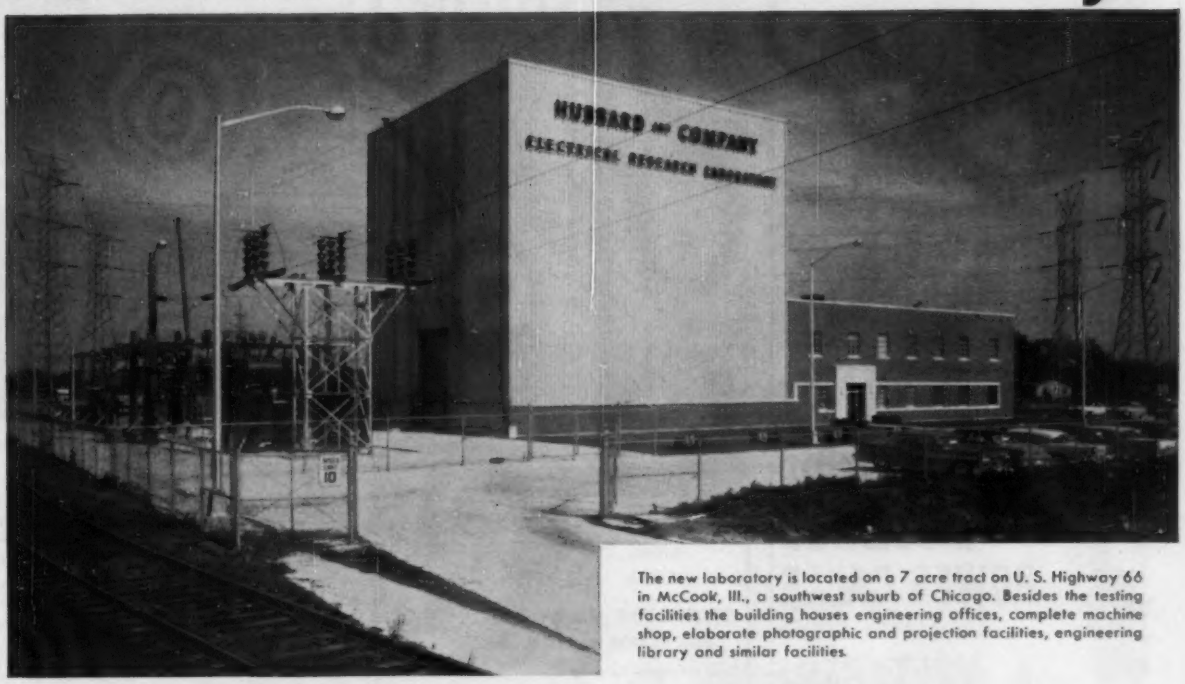
Of the five lightning generators included in the laboratory this 500 kv generator can be adjusted to produce a variety of waveshapes

Bronze dedication plaque at entrance to laboratory.



Outdoor laboratory—for comprehensive electrical and mechanical tests on full scale, live operating systems.

HUBBARD Research Laboratory



The new laboratory is located on a 7 acre tract on U. S. Highway 66 in McCook, Ill., a southwest suburb of Chicago. Besides the testing facilities the building houses engineering offices, complete machine shop, elaborate photographic and projection facilities, engineering library and similar facilities.

What is it worth to KNOW?

What is it worth to know just what is needed in electric distribution equipment...to know just how to make it so that it will stand up under ALL conditions...to know just what steps are necessary to make a particular piece of equipment do a better job than was ever done before?

A number of years ago we reached the decision that KNOWING would be worth *whatever it cost*...and out of this decision came the now completed Hubbard Electrical Research Laboratory. Its purpose is to give new wings to Hubbard product design and development...to do this by integrating all engineering research and testing facilities in one area...to make development, research and testing as it should be ...a creative guild unto itself!

Yes, the laboratory is new; but not the idea on which it was built. Those who know Hubbard equipment realize that the higher standards to which Hubbard equipment has been held across the years is a basic result of the greater emphasis we have always placed on the testing phase. No one has ever gone further into this phase than Hubbard and Company. But now we have gone *still further*.

We have literally brought the field into the plant!

In this research center we can truly duplicate the worst possible conditions under which utility equipment can be expected to function. In it we can determine what to make and how to make it. In it we hope to find the means of solving problems heretofore unsolvable.

A few of the facilities are briefly described here—more fully in a new brochure available for the asking. Those who have an interest in the work we are doing are cordially invited to make a personal inspection of the new laboratory.

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INCLUSIVE

With a complete range of voltages and sizes, Continental Wire offers POWER CABLE in types V . . . AIA . . . AVA . . . AVB . . . *SILICONE RUBBER* . . . TEFLON TAPE . . . and VARNISHED GLASS TAPE for extremely high temperatures. For power cable with excellent current carrying capacities, resistance to oil, grease, corrosive vapors, moisture, as well as high temperatures—call CONTINENTAL, Wallingford.

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Over a Quarter Century of Rectifier Manufacturing

BIBLIOGRAPHY
on
GASEOUS
DIELECTRIC
PHENOMENA
(April 1957)

The purpose of this 52-page bibliography is to provide an aid to the study of electrical phenomena in gases. There are well over 500 references and the arrangement is chronologically reversed in order to bring the most recent work forward. The order in each year's group is alphabetically arranged by first author.

Publication S-97 has been prepared for the Gaseous Dielectric Subcommittee under the sponsorship of the AIEE Committee on Dielectrics.

The price is $0.75. Send orders to Order Department.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

Industrial Notes

(Continued from page 60A)

Semiconductor-Components Plant. Texas Instruments Incorporated (TI) dedicated its 310,000 square foot plant for the manufacture of transistors and other semiconductor devices by using the signal from the American satellite Vanguard to cut the traditional ribbon. TI-made transistors were used in the instrumentation of the Vanguard satellite. The new plant, located on the 300-acre tract in northeast Dallas,

Courtesy Texas Instruments

represents an expansion of the company's facilities and houses the Semiconductor-Components Division. It is the first of a number of buildings planned for the site to serve research, manufacturing, and administrative functions. The building, exclusive of equipment and site, is one of the most modern and flexible manufacturing facilities in the electronics industry; it represents an investment of more than $5 million.

Division to Subsidiary. Plans for the separate incorporation of Space Technology Laboratories have been announced by Dr. D. E. Wooldridge, president of The Ramo-Wooldridge Corporation, 5500 W. El Segundo Blvd., Los Angeles 45, Calif. Space Technology Laboratories, the portion of Ramo-Wooldridge responsible for systems engineering and technical direction of the Air Force Atlas, Titan, and Thor ballistic missiles programs, has functioned previously as a separate, autonomous division of the company. According to Dr. Wooldridge, conversion of the Laboratories to a subsidiary corporation is a planned organizational step to improve the efficiency of the Space Technology Laboratories by completing its operational separation from the different kind of work performed by the other half of The Ramo-Wooldridge Corporation.

Bendix Expands. The Computer Division of Bendix Aviation Corporation has announced it has enlarged its district office and staff in New York, N.Y., and has established a computing center there. The office, at 205 E. 42nd St., is under the directon of R. P. Fopeano. The Division said the office now is equipped with a Bendix *G-15* digital computer and accessory equipment and has additional technical sales support.

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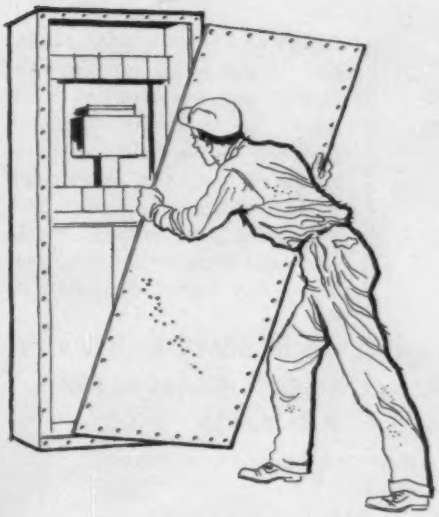
I-T-E

METAL-CLAD SWITCHGEAR



HOW MUCH DO YOU NEED A HINGED REAR DOOR?

Some switchgear makers say you don't need it at all. They say you should struggle with a 75-lb. sheet metal cover and grope for the screw holes. That's good enough for you, they say.

But I-T-E gives you hinged rear doors as standard equipment on metal-clad switchgear—at no extra cost. And many other features besides. More solid construction throughout . . . means longer life. Sturdier enclosures to simplify installation. Finer finishes to give your whole switchboard a richer look. Examine an I-T-E switchgear installation. It is just plain better built. But you pay no more.

How much do you need I-T-E's double blowout coils —standard on 15 kv circuit breakers? Under all fault currents, here is extra protection, plus assurance of longer circuit breaker life that no other switchgear offers you. Yet I-T-E charges you no more.

Recently I-T-E developed FLAMETRAP insulation that snuffs out flame in seconds and leaves no toxic fumes. It is today's most advanced flame retardant insulation—now yours on I-T-E switchgear for no extra cost.

This briefly is I-T-E's policy: to make its switchgear better, in construction, performance and appearance—but to charge no more. Why not make sure that you get all the value your switchgear dollars can buy. Get I-T-E switchgear. For a complete outline of our extra-quality features, write Switchgear Division, I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E

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Proceedings of the 1957 Electronic Components Symposium

This symposium, held in Chicago, Ill., May 1-3, 1957, was sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Radio-Electronics-Television Manufacturers Association, and the West Coast Electronic Manufacturers Association, with active participation by Agencies of the U. S. Department of Defense and the National Bureau of Standards.

The 46 informative papers are divided into the following categories:

Session I—Introductory
Session II—Components 1
Session III—Nuclear and Environment Studies
Session IV—Components 2
Session V—High Temperature Investigations and Development
Session VI—Instrumentation and Measurement
Session VII—Materials
Also included: Three luncheon speeches

The 282-page book is priced at $5.00. Send remittance and order to:

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Several attractive openings are available with a highly regarded, major Eastern engineering company. These positions require Electrical Engineering graduates with 5-10 years experience in corrosion control investigations, corrosion testing and solution of corrosion problems on pipelines, underground cables, power plant structures, piers, wharves, water and oil storage tanks, etc.

These positions offer ample opportunity for professional growth and personal achievement. Considerable travel within the USA with possibilities of some overseas work. We invite you to investigate these opportunities by forwarding a complete confidential resume.

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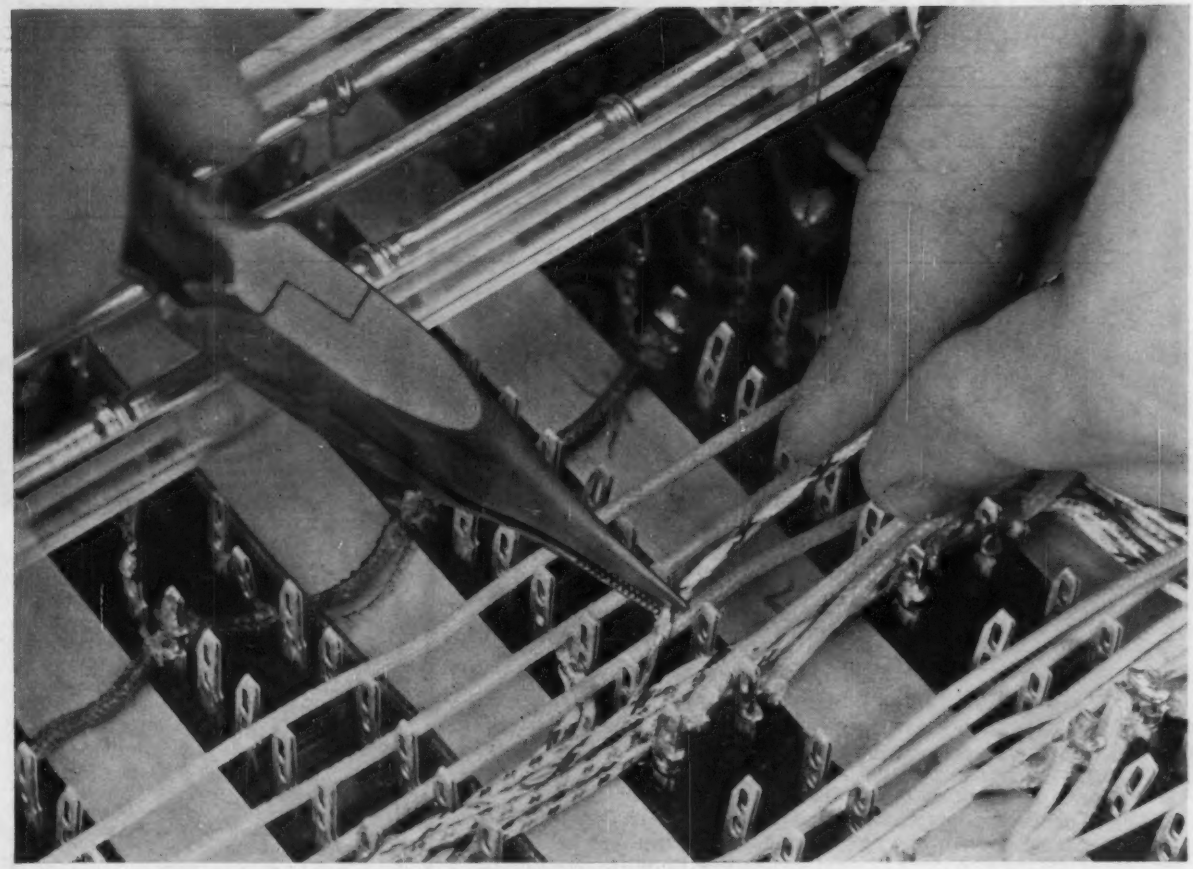
JOINTING, SPLICING, and TERMINATING COPPER and ALUMINUM CONDUCTORS

The Educational Committee of the Power and Industrial Division, AIEE New York Section, presented a Special Study Group in Spring 1956 in which technical data on the jointing of copper and aluminum conductors of all types was "packaged" for the first time.

The "Jointing" texts from eight lectures, have been assembled in a practical 54-page guide on the subject of electrical connector design and application, with specific reference to aluminum and aluminum-copper connections. Price: $2.25. Publication S-94 may be obtained from: Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York 18, N. Y.



Memo to control systems manufacturers:

If you've got a really tough cable problem, Rome's cable specialists can solve it

One sure way to solve your really tough cable problems is to call in a cable specialist. At Rome Cable you'll find a complete group of specialists—men experienced in the design and manufacture of conventional *and* special wires and cables.

Femco Inc.—a communications and control systems manufacturer—recently turned to Rome's engineers for the communications cable in one of their unique control systems. Special heat- and moisture-resistant, rubber-insulated cable—consisting of twisted pairs with one pair shielded—was designed. Rome Cable built 50,000 feet of it to interconnect Femco's Pagephone stations. A standard heat-resistant thermoplastic machine tool wire was used for the pit cover control.

Cable that best meets your need

As Femco Inc.—and many others—have learned from experience: you get exactly what's required to do the job from Rome Cable. If *standard* wire and cable are adequate for the job, Rome's engineers will recommend that you use them. If, on the other hand, you need a *special* cable, they'll design and build whatever your equipment requires. Our years of experience in handling difficult cable-building assignments can be of real value when your cable problem is really a tough one. Why don't you let us give you a hand?

Contact your nearest Rome Cable representative for more information—or write to Department 400, Rome Cable Corporation, Rome, New York.

SPECIAL CABLE FOR FEMCO. Rome's engineers designed a special cable to interconnect Femco's Pagephone stations. 50,000 feet of custom heat- and moisture-resistant Pagephone cable were supplied by Rome Cable for this unique application.

ROME CABLE

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NEW career opportunities with MOTOROLA in Chicago

Here is opportunity *unlimited* for men who like challenges and the rewards that go with accomplishment. Grow right along with dynamic 2-way radio communications, or work on important assignments from the armed forces.

You'll enjoy working at Motorola in well-instrumented laboratories, with men of the highest technical competence. Many liberal employee benefits, including an attractive profit sharing plan.

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TRADE LITERATURE

Magnetic and Motorized Valves. Within its 24 pages, Catalog *V-58* illustrates and lists specifications of magnetic and motorized valves for use with air, water, gas, steam, oil, and refrigerants. Also included are solenoid coil rating tables. Another feature consists of two flow charts, one for liquids, the other for compressible fluids. Dimensional drawings are included. Write to The Mercoid Corporation, 4201 Belmont Ave., Chicago 41, Ill.

Connector Test Bulletin. A 29-page test report detailing the laboratory testing of miniature electrical connectors is available. The report describes a complete series of tests for electrical, environmental, and physical characteristics. Copies can be obtained by writing to The Deutsch Company, 7000 Avalon Blvd., Los Angeles 3, Calif.

"METERS." An 8-page quarterly technical bulletin entitled METERS (Measuring & Electronic Test Equipment Reports) has been introduced by the instruments group of the Industrial Products Division of International Telephone and Telegraph Corporation, Clifton, N. J. The publication will describe problems in instrumentation and measurement and suggest methods for overcoming them. It will also explain the design and operation of high quality laboratory measuring devices. Engineers and other qualified personnel may obtain copies of the bulletin from Richard Hess, Industrial Products Division, International Telephone and Telegraph Corporation, 250 Garibaldi Ave., Lodi, N. J.

Relay Bulletin & Chart. A 4-page colored brochure, No. *85-3*, has recently been issued, featuring complete illustrations, technical descriptions, and prices of 132 relays that are stocked by distributors. These include a complete line of sub-miniature, sensitive, power, antenna, telephone type, and hermetically sealed relays. A cross-reference relay chart *S200-A* shows the electrical and mechanical equivalents of 17 leading relay manufacturers. Copies available from Kurman Electric Co., Division of Norbute Corp., 191 Newel St., Brooklyn 22, N. Y.

Service Station Lighting and Wiring Bulletin. "Service Station Lighting and Wiring" is a 24-page bulletin listing condulets and floodlights combined with recommendations for electrical installations in conformance with the National Electrical Code. Write Crouse-Hinds Company, Syracuse 1, N. Y., for a copy of Bulletin *2704*.

Automatic Welding Folder. *DM-73*, a folder on all types of automatic and semi-automatic welding equipment covers power sources, wire-feed mechanisms, guns, heads, and controls for submerged arc and inert-gas-shielded arc welding. Write Hobart Brothers Co., Troy, Ohio.

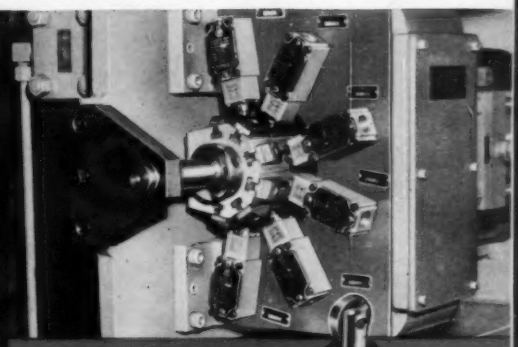
(Continued on page 81A)

ALLEN-BRADLEY

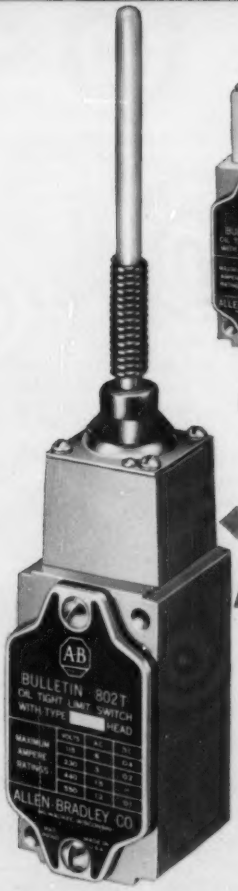
BULLETIN 802T

OILTIGHT

LIMIT SWITCHES



Radial mounting of six Allen-Bradley "manifold" type, push roller, oiltight limit switches.



WOBBLE STICK TYPE

SIDE PUSH ROD

FORK LEVER TYPE

ADJUSTABLE ROD

TOP PUSH ROD WITH PLASTIC WINDOW

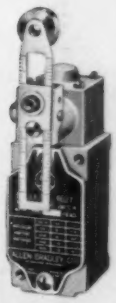
Push roller, oiltight limit switch, showing rubber grommeted wiring hole on back of "manifold" type, used on above automatic production machine made by Cross Company, Detroit.

OIL SEALED HEAD AND BODY

assure reliable operation

Completely sealed . . . oil, dirt, and metal chips cannot foul up contacts or operating mechanism. Operating heads are interchangeable—can be mounted in any one of four positions. New "wobble stick" heads operate in any direction. All of these limit switches have maintenance free, double break, silver alloy contacts. Specify Allen-Bradley—the *quality* line of limit switches.

ROLLER LEVER FOR CAVITY MOUNTING



ADJUSTABLE ROLLER LEVER

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

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In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

9-58-R

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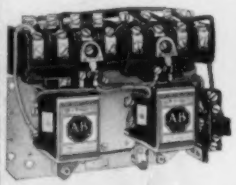
D. C.
MOTOR STARTERS
with modern
SOLENOID CONTACTORS

With Allen-Bradley, you get D. C. motor control that is *completely modern!* It uses the simplest switching mechanism yet conceived . . . the solenoid contactor with only ONE moving part. There are no bearings to stick . . . no jumpers to break. This assures millions of trouble free operations. And the double break, silver alloy contacts never need maintenance. Available in ratings up through Size 4. Write for details.

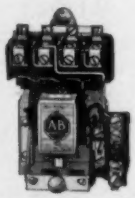
CONTACTORS

Bulletin 202 solenoid type contactor. In ratings to 150 amp. Also, clapper type to 600 amperes.

FULL VOLTAGE STARTERS

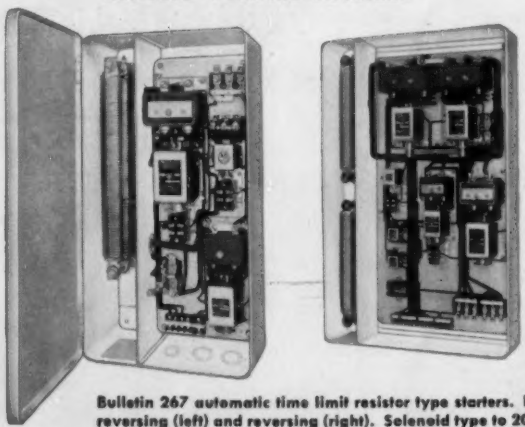


Bulletin 205 full voltage reversing starter. Ratings to 1½ hp, 115 v; 2 hp, 230 v.



Bulletin 209 full voltage starter. Available in ratings up to 1½ hp, 115 v; 2 hp, 230 v.

REDUCED VOLTAGE STARTERS



Bulletin 267 automatic time limit resistor type starters. Non-reversing (left) and reversing (right). Solenoid type to 20 hp, 115 v; 40 hp, 230 v. Clapper to 75 hp, 115 v; 150 hp, 230 v.

9-58-MR

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Bobbin Wound Cores

Molybdenum Permalloy Powder Cores

Iron Powder Cores

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Special Magnetic Materials

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TECHNICAL DATA YOU NEED

Bulletin TC-101 A . . . Properties, standard sizes, etc. of Arnold Tape Wound Cores.

Bulletin PC-104 B . . . Complete data on Mo-Permalloy Powder Cores.

Bulletin GC-106 C . . . General information on Magnets and other Arnold products.

Bulletin SC-107 . . . Covers the complete range of Arnold Silectron Cores.

Bulletin TC-108 A . . . Describes properties, etc. of Arnold Bobbin Cores.

Bulletin PC-109 . . . Essential data on Arnold Iron Powder Cores.

Bulletin SDC-110 . . . Information on properties, etc. of Sendust Powder Cores.

Bulletin TC-113 A . . . Technical data on Arnold Supermendur Tape Cores.

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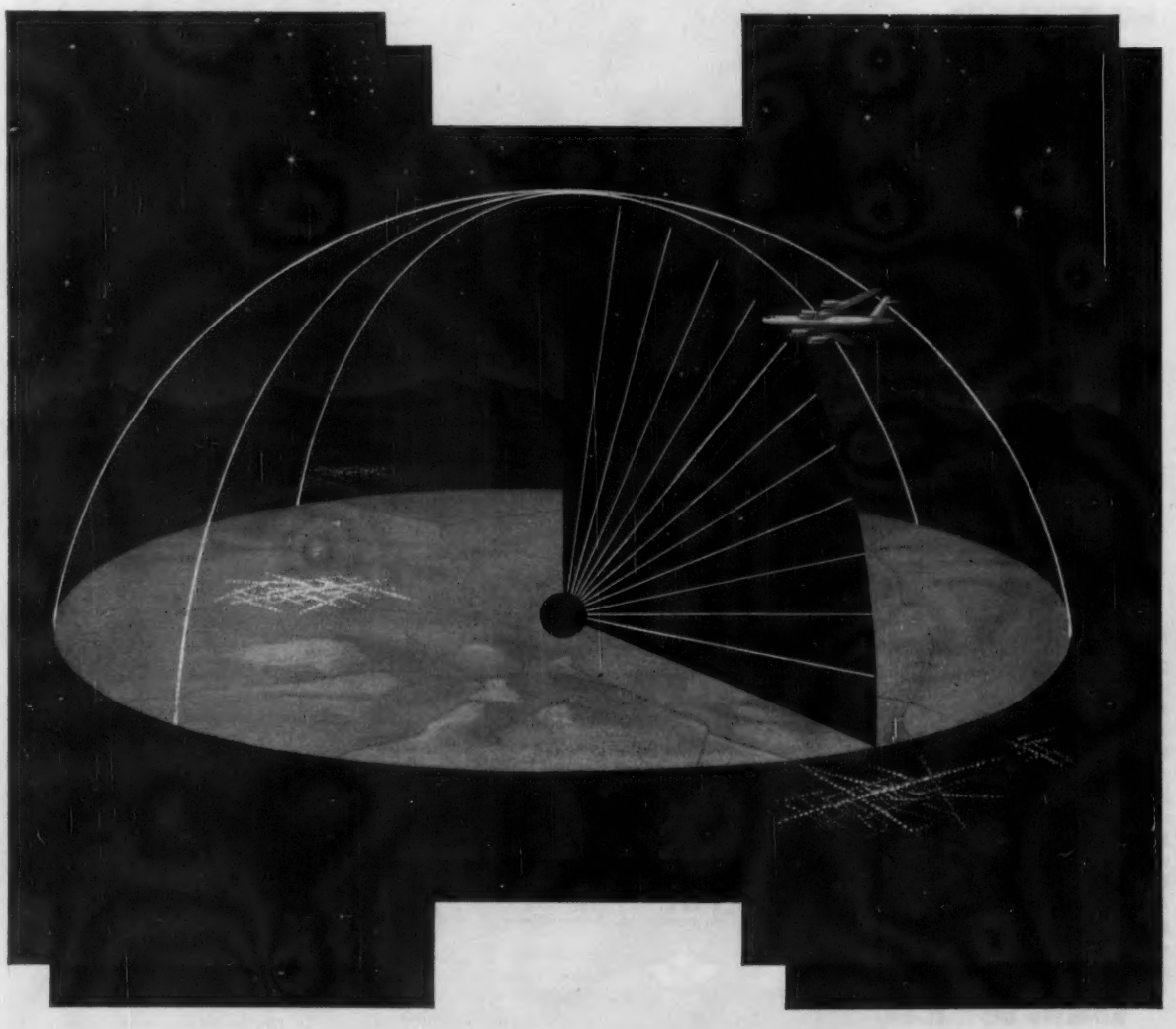

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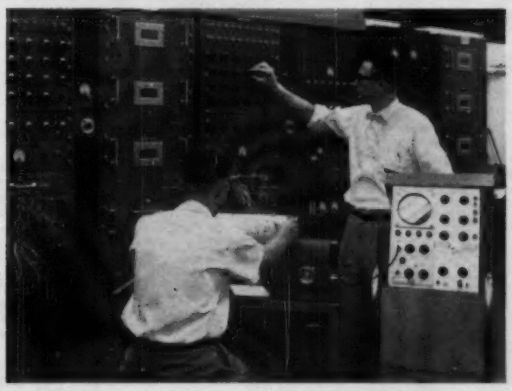
To achieve umbrella-like radar protection Hughes engineers at Fullerton, California, have developed systems which position radar beams in space by electronic rather than mechanical means. These unique three-dimensional radar systems are digitally programmed to instantaneously detect high-speed enemy aircraft, even at low altitude.

Other defense systems under development at Hughes in Fullerton are Data Processors which monitor the movement of hundreds of aircraft, store the information and assign defense weapons; radars with beams capable of detecting and tracking missiles; and new radar systems for installation on surface and subsurface naval vessels.

Other Hughes activities are delving into similarly advanced areas of electronics. Engineers at Hughes Research & Development Laboratories are probing into the effects of nuclear radiation on electronic equipment, studying advanced microwave theory and applications, and examining communication on a spatial scale. Applying this advanced type of creative engineering to commercial projects is the task of engineers at the Hughes Products activity.

The highly advanced and diversified nature of Hughes projects offers creative engineers and physicists the opportunity to build a rewarding career in a progressive and expanding environment.



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Two weekly bulletins of engineering positions open, one covering positions on the Pacific Coast and the other covering Midwestern and East Coast positions, are published and each bulletin is available to members at a subscription rate of $3.50 per quarter or $12.00 per annum, and to nonmembers at $4:50 per quarter or $14.00 per annum.

Men Available

SALES MGR, SALES ENGR, OR SALESMAN, B.S.E.E., 60, registered P.E., New Jersey; 30 yrs exper, close contact with engrs, architects, electrical wholesales, and electrical contractors. Location desired: Northern New Jersey. E-996.

PRODUCT PLANNING AND MARKET DEVELOPMENT MGR, B.A. and M.S. in E.E., 35, registered, with large electrical manufacturer for 10 yrs and exper'd in development, design, product planning, application engrg, and sales of industrial electronic controls and systems. Desires responsible position with progressive electrical manufacturer. Location desired: Northwest, Northeast, Southwest. E-997.

DISTRIBUTION ENGR OR SALES ENGR, graduate engr—electrical (power), 57, exper in sales of electrical equipment, also 6 yrs in distribution, 3 yrs in generation. E-998.

PROJECT ENGR, GEN'L MGR OR CHIEF ENGR, B.S.E.E., 44, P.E., grad work, project engr, former general mgr, chief engr of consulting engrg firm. Worked on control devices, corrosion control and cathodic protection systems, radio noise, servomechanisms, underwater ordnance, electric power, 22 yrs. Location desired: Midwest or East. E-999-844-Chicago.

Positions Available

PROJECT ENGINEER, B.S. in electrical engineering or B.S. in radio engineering, with three to five years' experience on specialty motor design and development. Experience on miniature Will design and develop miniature 400 cycle gear motors, servos, synchronous motors, etc. motor, small alternators, induction motors, etc. Location, New Hampshire. W6257.

ENGINEERS. (a) Physicist, B.S. or M.S. in physics, with two to five years' experience, including some work in heat and light radiation. Work is in a fundamental area of applied research and development. (b) Electronic Engineers, B.S. or M.E. in electrical engineering, with at least two years' experience in electronic circuit and systems design, for electronic control circuit and systems design. (c) Mechanical Engineers, B.S. or M.S. in mechanical engineering, with from two to five years' design experience. Background in packaging, printing or materials handling desirable, for mechanical design of various types of card and paper converting equipment. (d) Junior Mechanical Engineers, B.S. in mechanical engineering, with high interest and aptitude in mechanical design. Recent graduates in the upper quarter of their classes preferred. Work will consist of mechanical design of various types of card and paper converting equipment. Location, New York State. W6259.

TEACHING PERSONNEL. (a) Assistant, Associate Professor, Ph.D. or Sc.D. in Power Field. To teach senior and graduate courses in rotating machinery and direct theses and research in this area. (b) Assistant, Associate or Professor, Ph.D. or Sc.D. in electronics. To teach senior and graduate courses in this area and direct theses and research in this field. Rank and salary dependent on experience and capability. Positions available September, 1958, June or September 1959. Location Midwest. W6263.

PRODUCT DESIGNER, ELECTRICAL graduate, with at least five years' design, development and application experience on rectifying controls. Salary, $8000-$10,000 a year. Location, Connecticut. W6273.

ELECTRONIC ENGINEER, B.S. or M.S. degree, with design and development experience covering pulse techniques, lumped and distributed parameter delay lines. Company will pay placement fee. Salary, to $8000 a year. Location, Queens, New York. W6285.

RESEARCH AND DEVELOPMENT ENGINEERS, graduate physicists or electronic engineers, Ph.D. preferred, with experience in data handling and process, on digital and analog computers and associated data handling equipment. Salary, $8000-$14,000 a year. Company will negotiate fee. Must be U.S. citizen. Location, Westchester, New York. W6286.

ASSISTANT PLANT ENGINEER, graduate, mechanical or electrical, to assist plant engineer in regular plant engineering work; design new facilities and engineering facility improvements and assist in the supervision of plant maintenance work. Position will lead to that of plant engineer. Salary open dependent upon amount and type of experience. Location, Louisiana. W6287.

ASSISTANT PLANT ENGINEER, electrical graduate, with industrial electronic experience including high frequency induction equipment in process industries. Salary, $7000-$8000 a year. Location, central Pennsylvania. W6289.

SALES ENGINEER, with instrumentation or control background. Preferably some sales experience. Knowledge of oil or chemical industries. Salary, $7200-$7800 a year. Location, Metropolitan New York and northern New Jersey. W6312.

ENGINEERS for a nuclear division. (a) Reactor Controls Engineer to conduct analytical and theoretical studies on reactor controls problems. Design and test of complete reactor control systems. Degree or equivalent plus two years' experience. Salary, to $15,000 a year. (b) Nuclear Analysis Engineer to conduct analysis and make mathematical calculations in connection with reactor design problems and aircraft nuclear propulsion. Degree or equivalent and minimum of two years' experience. Salary, to $14,500 a year. (c) Heat Transfer Specialist to handle problems concerning nuclear reactor heat transfer and fluid flow. Degree or equivalent and a minimum of two years' experience. Salary, to $14,000 a year. Location, East. W6316.

ENGINEERS for a nuclear division. (a) Nuclear Power Systems Engineer to analyze and design steam and electrical portions of nuclear power systems. Degree or equivalent and a minimum of one year's experience. Salary, to $14,500 a year. (b) Nuclear Development Engineer for the conception and preliminary design of new systems in the nuclear power field and the determination of economic and operational characteristics of such systems. Salary, to $14,000 a year. Location, East. W6317.

DEVELOPMENT ENGINEERS. (a) Senior Development Engineer, electrical graduate, with at least five years' R F receiver experience preferably on military equipment. (b) Junior Development Engineer, graduate electrical or mechanical, for electronic development work covering receiving systems. Salaries open. Location, Philadelphia, Pennsylvania. W6319.

PLANT MANAGER, electrical or ceramic engineering experience preferred, for a growing producer of solid-state electronic component. Will be responsible for the management, production, personnel and costs of a facility composed currently of 60 employees. Salary, $10,000-$12,000 a year. Prefer a resident of eastern Fairfield County, Connecticut. Location, Connecticut. W6324.

DIRECTOR OF RESEARCH, Ph.D. in physics, an absolute requirement; with some experience on servo-mechanisms, calculating machines and computers. Will head up a group of ten people on applied research. Salary, $13,500 a year plus bonus. Location, Connecticut. W6329.

PROJECT ENGINEER, graduate electrical with major in audio and hi-fidelity desire five years' experience, to take project responsibility in a product design and development laboratory working on loudspeakers and enclosure phonograph cartridge and systems, magnetic tape recording and associated audio, hi-fidelity devices and problems. Specific experience in field is desirable but not essential. Salary, $6060-$7920 a year. Location, Westchester County, New York. W6331.

SENIOR ENGINEERS. (a) Electronic Circuitry, advanced design work involving pulse, digital, video and sweep-type circuitry. Transistor experience desirable. (b) Electro-Mechanical Systems and Components to do analytical studies and advanced engineering involving some knowledge of aerodynamics, thermodynamics and reliability under extreme environmental conditions. Salaries, $8000-$12,000 a year depending upon experience. Company will pay placement fee. Location, Maryland. W6335.

DEVELOPMENT ENGINEER, graduate mechanical or electrical, with three or more years' experience in mechanical development work. Experience in textiles desirable but not required. Will assist in research, on planning and development of new machinery and the improvement of existing machinery. Assignments are essential project type with full responsibility for completion. Salary open. Location, South. W6336.

SALES ENGINEERS. (a) Sales Engineer, senior, Marketing, B.S. in E.E., with three to five years' experience in manufacturing and five years' experience in manufacturing and sales, including a thorough knowledge of plant equipment and manufacturing capabilities. Under general direction of sales manager-electronics, will contact, follow up and sell present and potential customers assigned, equipment manufactured by defense products division. Salary, $10,000 a year plus or minus. (b) Sales Engineer, Nuclear, with three to five years' sales experience on reactor control instrumentation systems and equipment. Salary, $8000-$10,000 a year. Headquarters, New York Suburban area. W6346.

RESEARCH ENGINEERS. (a) Senior Research Engineer, Systems Management and Engineering, minimum of B.S. in E.E., advanced degree desirable; minimum of five years' experience in nuclear engineering, transistor circuit design and allied fields. Will be responsible for direction of department activities in area of specialized nuclear instrumentation equipment involving the use of transistors. Salary, $10,000 a year plus or minus. (b) Senior Research Engineer, Systems Management and Engineering. M.S. in M.E., E.E. or mathematics with ten to fifteen

(*Continued on page 76A*)

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—TYPE E 17—

Some of the Distinctive Features:

- Perfect insulation is provided for each terminal, by making the protective terminal independent from the line terminal.
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2,000 Volt Class

The efficiency is perfectly in conformity with the established JIS's clauses for small type high tension and high resistance ratings, and proves satisfactory in the absolute tension test with standing A.C. 3,000V for one minute.

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The efficiency is perfectly in conformity with the established JIS's clauses for small type insulation testers.
Its precision as an electric conductor tester is within ±5% of the indication of each scale.
This class is both available for insulation resistance tests and for conductor resistance tests, with the change-over switch.

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67 Broad Street • New York

Personnel Service, Inc.

(Continued from page 74A)

years' experience which must include mathematical analysis, design and application of gyros and stable platforms, servo control, hydraulic and electro-magnetic actuators, and general instrumentation type of mechanical design. Will assume full program responsibility for the development of airborne stabilization systems of extreme accuracy as regards steadiness and position; will encompass all phases from proposal and estimating to final delivery of completed hardware, including study, analysis, design, fabrication and testing. Salary open. Location, New York Suburban area. W6347.

ELECTRICAL DESIGN ENGINEER to assist research director. Will have responsibility for design of small household electrical appliances; will specify materials, satisfy all U.L. requirements an dact as technical advisor on product design, field service and consumer acceptability. Salary open. Location, New York State. W6354.

PRODUCT DEVELOPMENT ENGINEERS, B.S.M.E. or B.S.E.E., graduate work desired; with two to six years' experience in product development; research or prototype production of small precision instruments or aircraft components. Knowledge of hydraulics, pneumatics, fluid flow and dynamics essential, preferably experience in these fields. Will assume responsibility for certain projects in the development and early production stages of company's products. Salary, to start, $8500-$12,00 a year. Company will negotiate placement fees and relocation expenses. Location, upstate New York. W6358.

MANAGER, Special Product Sales, B.S. in E.E., with five to ten years' of sales experience in the fields of resistors and transistors. Will direct, plan and administer sales functions pertaining to electronic industry including customer contacts and relations, pricing distribution, field product development, collection of market data and information, coordination of activities with other departments as required. Will administer and promote maximum sales of electronic products to domestic and foreign customers. Salary, $12,000-$18,000 a year, which includes a profit sharing arrangement. Headquarters, Pennsylvania. W6365.

ENGINEERS. (a) Engineering Manager to head up the installation and servicing section; ten to fifteen years' experience as production manager; airborne radar and navigational instruments. Salary, $18,000-$20,000 a year. (b) Electronic Engineers, with airborne electronic experience; four to seven years' in either design, field testing or production; some contract supervision. Salary, $10,000-$12,000 a year. Location, Canada. F6375.

MAINTENANCE ENGINEER, graduate electrical, to take full charge of maintenance, trouble shooting, estimating, new and repair installations on elevators. Experience with Otis, Westinghouse, etc., very desirable. Salary, $10,000 a year. Location, New York Metropolitan area. W6378.

PRODUCTION ENGINEER, graduate mechanical or electrical, with minimum of five years' experience in electronic component manufacture. Must be heavy on design for production. Salary, $13,000 a year. Location, Connecticut. W6383(a).

CHIEF ENGINEER, mechanical or electrical graduate, for a large firm of consulting engineers to take over a district office. Company is engaged mostly in the design of air conditioning, heating, electric light and power for commercial industrial and institutional buildings. Must be strong on design and management. Salary high. Location, New York, N. Y. W6384.

ELECTRONIC ENGINEER, graduate, with three to four years' experience with low level D.C. transistor amplifiers. Salary open, Location, western New York State. W6391.

SALES ENGINEER, graduate electrical, with two to five years' on-the-job performance, preferably in the electronics field, i.e., communications, broadcasting, CAA, etc. Sales experience preferred but not essential. Will handle extensive line of special purpose recording machines. Excellent opportunity. Some travel in Midwest. Salary, $7000 a year, all expenses paid, fringe benefits. Location, Chicago, Illinois. W6400.

ELECTRICAL ENGINEERS. (a) Electrical Design Engineer, graduate, to independently perform designs for circuits and small systems; plan, carry out and analyze the results of electrical experiments with semi-conductors and passive magnetic circuit elements. Minimum of one year in development or product engineering. Salary, $6900-$9000 a year. (b) Junior Electrical Engineer graduate, to perform electrical design of transistor circuitry and logical devices under supervision. Will assist in circuit development and product engineering; building test models of individual circuits. Salary, $5520-$6600 a year. Location, Southwest. W6402.

ELECTRICAL ENGINEER — Communication, prefer B.S., but not required, with some experience in developing commercial radio equipment to design and development HF single side band radio telephone equipment for small manufacturer. Salary, $7200 a year. Location, Northwest. S3651.

SALES ENGINEER, electrical, several years' experience allied to utility field, electrical jobbers or distribution system hardware. Sell electrical equipment (switchgear, pole lines, hot line tools, insulators, etc.) to jobbers utilities, power engineers, warehouses, linemen, construction men. Salary, $7000 a year. Locations: One for Northwest, one for northern California and Nevada. S3661.

PROJECTS ENGINEER, electronics, E.E. degree, with experience on pulse and digital circuit or nuclear instrument. To take charge of instrument design project. Citizenship not required. Salary, $6900-$9000 a year depending on qualifications. Location, San Francisco East Bay. S3676.

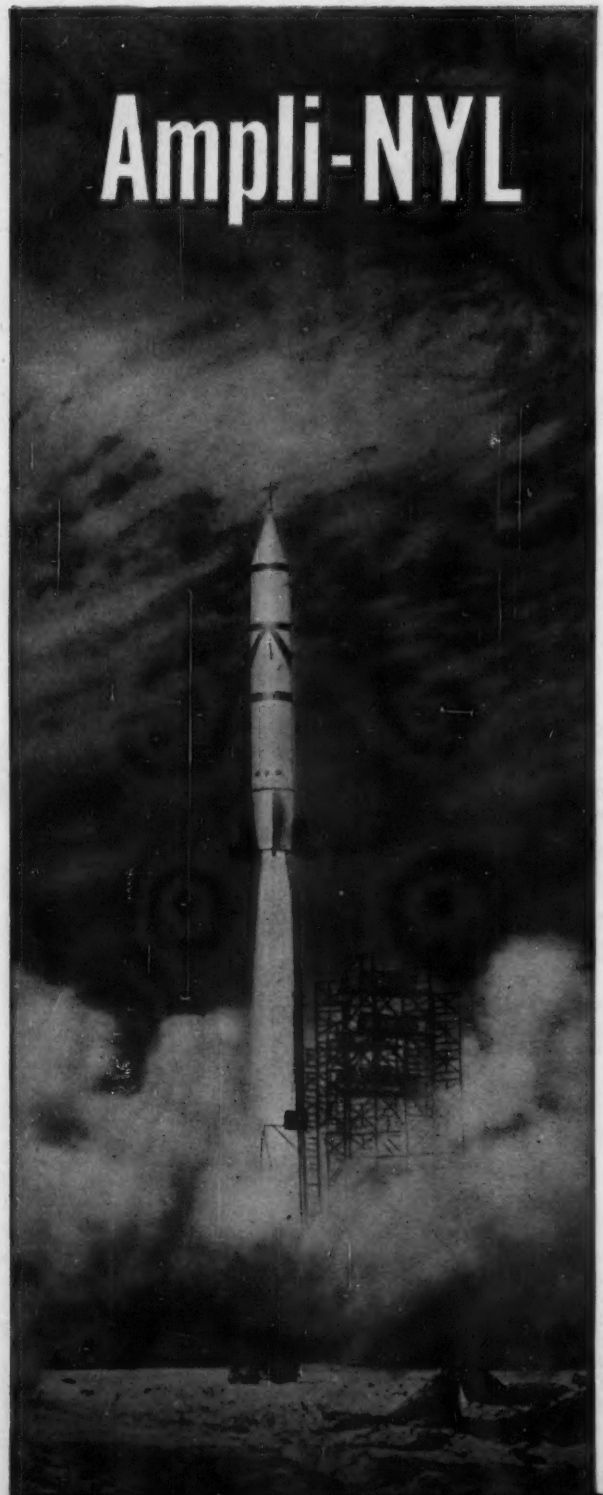
ELECTRICAL ENGINEER, publication works, E.E. or equivalent, eight years' experience electricity and engineering, four years' of which managerial or supervisory level. Thorough knowledge of electrical engineering, planning, development and direction of installation, rehabilitation and repair and maintenance of electrical facilities and equipment. Direct and participate in preparing and reviewing of elecerical plans, specifications, bills of materials and cost estimates; for power and light distribution systems; familiar with programming and scheduling. Advise and assist on plans, design, construction or installation, maintenance of electrical distribution lines, secondary wiring, substations, transformers, motors, fixtures and maintenance of electrical systems and equipment. Salary, $12,000 a year. Location, Korea. S3682.

SALES—Electro-mechanical, E.E. or M.E., well qualified to sell directly to industrial users and/or OEM, a product application job on electrical portable furnaces, electro-mechanical devices, testing, equipment, automatic controls for established manufacturers' agent, with San Francisco headquarters and offices throughout West. Knowledge of metallurgy desirable. Salary, $6600 a year, plus profit sharing, expenses and care mileage, benefits. Location, San Francisco. S3705.

SALES ENGINEER, wire, cable preferably B.S.E.E., and preferably with some experience in electrical cable engineering; will consider man without cable experience. For engineering and sales assignments concerning electrical cables, primarily to government specifications and in missile field. Design, customer contact, assist sales department in quotations. Salary, $6000-$7000 a year. Location, Los Angeles. S3711.

APPRAISAL ELECTRICAL UTILITY ENGINEER, must know electric utility property valuation. Duties will include field inventory and preparation of valuation report for electrical utility including generation and distribution. Some travel, car required. Employer will pay placement fee. Salary open. Location, West Central, Illinois. C6944.

Ampli-NYL



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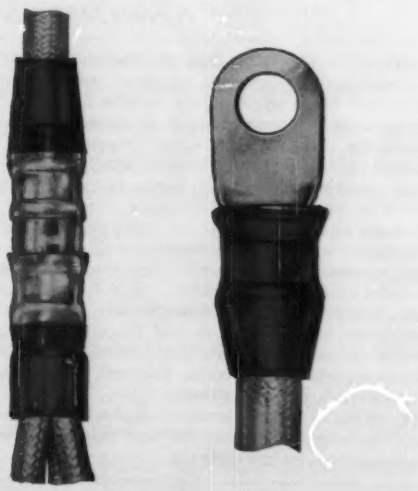

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Responsible positions. Degree essential. Experience as required.
Preliminary engineering: Conduct studies and evolve conceptual designs of power plant systems for mobile use. Prepare proposals and conduct design and economic analysis of commercial power plants.
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Systems analysis: Mobile compact reactor and power conversion system simulation and vehicle integration analysis.
Control analysis: Reactor kinetics and overall nuclear power plant control. Hazard analysis, using analog and digital computers.
Heat transfer and fluid flow: Steady-state and transient analysis. Power optimization studies, free and forced convection flow transients, boiling, and two phase flow. Analytical methods using analog and digital computers.
Stress analysis: Structural, thermal, and dynamic stress analysis of high temperature reactor systems.
Operations: Foreign, domestic, and advanced developmental reactor checkout, start-up, test operations, and customer training. Includes operational analysis and design criteria.

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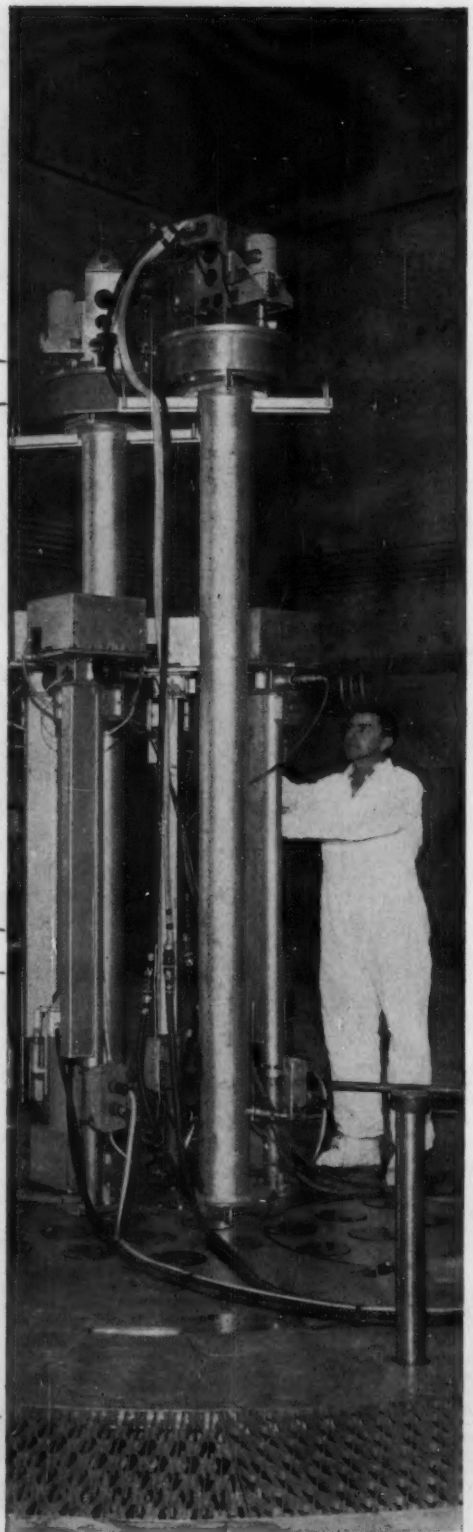

SRE Reactor Control Element Actuators. Sodium Graphite Reactor (SRE) uses eight control actuators. Four function as safety rods, two as shim rods, and two serve as shim regulating rods.

WARHEAD

circa 400 A. D.

Centuries ago, the Indians of New Mexico designed and developed warheads like this one.

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Here again, we at Sandia follow a similar pattern. In the pursuit of our main task, we study many things in widely-varied fields ranging from nuclear phenomena to numbers theory, from meteorology to metal-working. We learn basic scientific facts and advanced techniques that have important applications far removed from nuclear weapons.

We probe new frontiers of science and engineering. We meet and solve challenging problems in many areas of advanced technology. These are activities which require the services of outstanding engineers and scientists in many fields in our work to maintain our nation's defensive strength.

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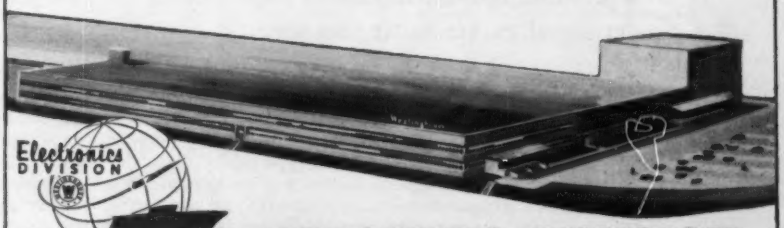

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Engineers at the Electronics Division of Westinghouse-Baltimore are pioneering in the fields of Communications, Missiles Ground Control Engineering, Advanced Development and Radar Engineering. The Division's modern plant offers the latest in facilities and equipment.

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- Magnetic Amplifiers
- Microwave Components
- Network Synthesis
- Pulse Circuitry
- Radar Systems
- Reliability
- Transistor Circuitry

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Graduate Electrical Engineer with a minimum of 10 years experience in power distribution, lighting and special control systems for industrial and chemical plants, including selection of equipment and installation design. Should be thoroughly familiar with available power equipment and governing codes. A P.E. license is desirable.

This position involves broad electrical engineering responsibility and challenge with a major engineering firm in the petroleum and petro-chemical plant fields. The opportunity promises excellent advancement, both in salary and administrative responsibilities.

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Requires B.S.,M.E. or E.E. with 3 to 5 years' experience in dynamic analysis and synthesis of servo systems using analog computers as an aid. Prefer direct experience with hydraulic and pneumatic systems. Will work on analytical group assignments relating to dynamic systems' analysis and synthesis on high-pressure electro-hydraulic devices, high-pressure pneumatic systems, jet engine fuel systems, etc.

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Senior Project Engineer is required to organize and assume charge of a small group engaged in the development of airborne equipment for the generation and use of high-pressure gas from cryogenic liquids, which will be used for control and actuation of various devices on aircraft and missiles.

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Qualified applicants will be invited to West Hartford plant for personal interview concerning these positions.

Trade Literature

(*Continued from page 68A*)

Mechanical Steel Tubing Bulletin. Free copies of a new 8-page technical bulletin, "Mechanical Steel Tubing," are now available from Rome Cable Corporation, Rome, N. Y. Detailed specification charts give complete information on size range, wall thicknesses, approximate weights, standard mandrel bends, and standard 90° bends without mandrels. Simple-to-follow instructions cover the most important points to consider when ordering.

Resin Data Chart. A large multicolored wall chart is now available showing a compilation of data for the various standard resins of Emerson & Cuming, Inc., 869 Washington St., Canton, Mass., a free copy of which can be obtained by writing.

QO Circuit Breaker Bulletin. A 16-page, 2-color bulletin on *QO* circuit breakers for residential, institutional, commercial, and industrial applications is available. It gives detailed description of *QO* breaker features and information on load centers and panelboards. Write for Bulletin *SD-100*, Square D Company, 6060 Rivard St., Detroit 11, Mich.

Thermistor Catalog. Described in Fenwal Electronics' catalog *EMC-2* are 15 different thermistor circuits. The 16-page brochure also gives specifications for nearly 400 different thermistors—including assemblies, matched pairs, beads, discs, washers, rods, and probes. Copies of the catalog may be obtained from Fenwal Electronics, Inc., Mellen St., Framingham, Mass.

Furnace Bulletin. A 22-page two-color Bulletin No. *242* has recently been released. It contains photographs and describes hardening, carbonitriding and carburizing furnaces of batch and continuous types. Request your copy of Bulletin *242* from the Lindberg Engineering Company, 2444 W. Hubbard St., Chicago 12, Ill.

Highway Lighting and Signing Guide. "Monotube Poles for Highway Lighting and Signing" is the title of a recently released 24-page folder. Popular highway pole designs, in both steel and aluminum, as well as various overhead sign mounting arrangements are illustrated and catalogued in easy-to-follow form. For a copy of Folder *LS-23*, address The Union Metal Manufacturing Company, Canton 5, Ohio.

Reprint on Croloy *15-15N*. Engineers and those associated with the design and operation of steam generating equipment will be interested in Bulletin *TR-555*, a reprint of a technical paper entitled, Croloy *15-15N*—An Austenitic Heat Resistant Alloy for Severe Tubular Application at Elevated Temperatures. This 11-page reprint describes the involved testing program and outlines the many characteristics of Croloy *15-15N*. Copies of paper *TR-555*, are available free on request from the general sales office, Tubular Products Division, The Babcock & Wilcox Company, Beaver Falls, Pa.

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GENERAL ELECTRIC ADVANCED ELECTRONICS CENTER at Cornell University has openings for experienced electronic engineers and physicists. As the Advanced Engineering Component of the Light Military Electronic Equipment Department, the Center is responsible for Applied Research and Advanced Development of Airborne Electronic Equipment. Current work at the Center includes Electronic Warfare, Radar, Communications, Data Processing, Weapons Systems Engineering, Proximity Fuses, Magnetic Amplifiers, Human Engineering, Infrared and Transistors. Replies stating education, experience and salary requirements should be addressed to Dr. Paul Doigan, General Electric Company, Advanced Electronics Center at Cornell University, Ithaca, New York. All replies will be kept confidential.

ASSOCIATE PROFESSOR for Electrical Engineering Department. Ph.D. degree preferred. Opening in electronics. Salary commensurate with experience and education. Position available September 1958. Write Head, Electrical Engineering Department, South Dakota School of Mines and Technology, Rapid City, South Dakota.

ELECTRICAL ENGINEER, physicist, chemist for fundamental project on effects of radiation on dielectrics. Capacitor experience desirable. Send resume to: Radiation Research Corporation, 1114 First Avenue, New York, New York.

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The papers of the third biennial conference, held in Toledo, Ohio, April 23-24, 1957, were directed primarily to users on a practical rather than a theoretical basis. The program began as a basic refresher course on the various types of electric heaters: resistance, direct resistance, radiant, induction, and dielectric. Full sessions followed with more advanced papers on each type of heater.

Publication T-96 is sponsored by the AIEE Committee on Electric Heating and the AIEE Toledo Section. The 126-page book consists of 18 papers. The price is $3.50. Send orders to:

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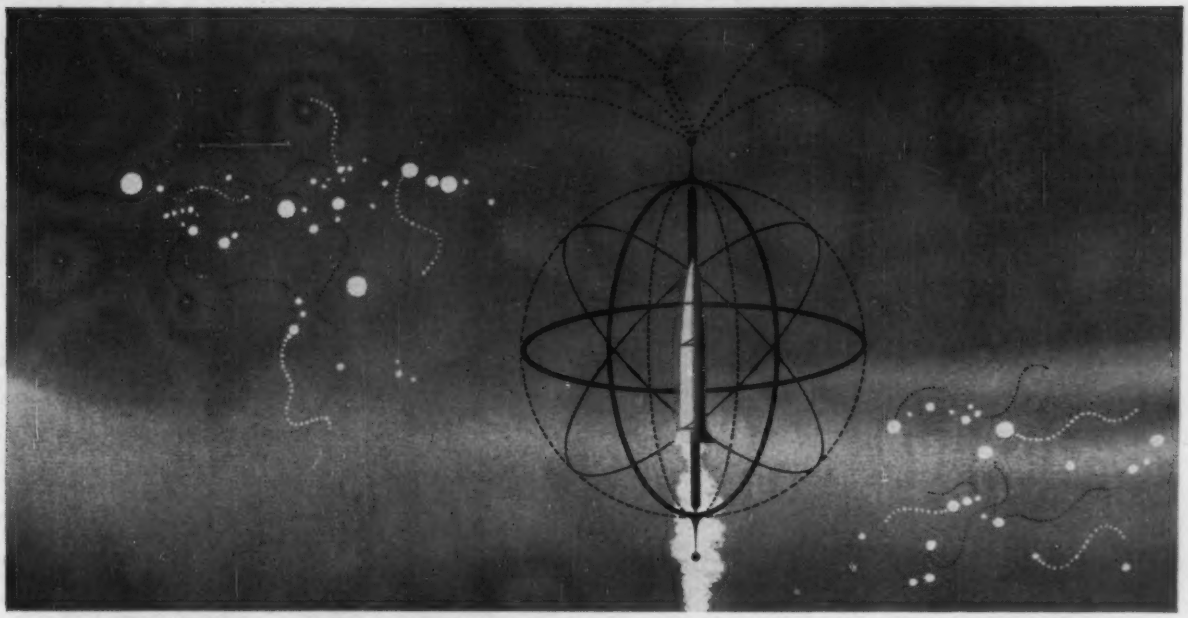

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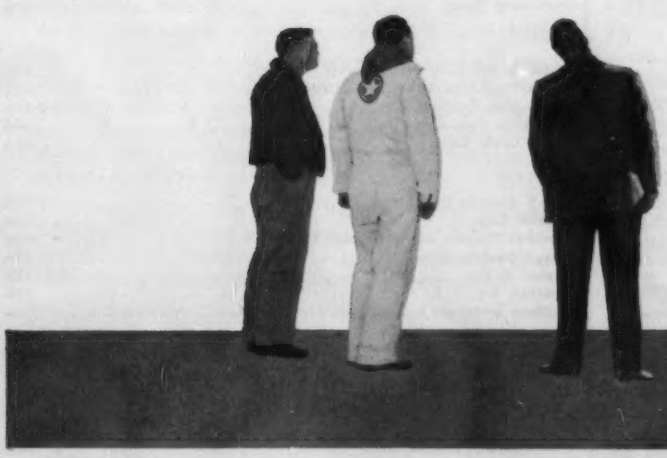

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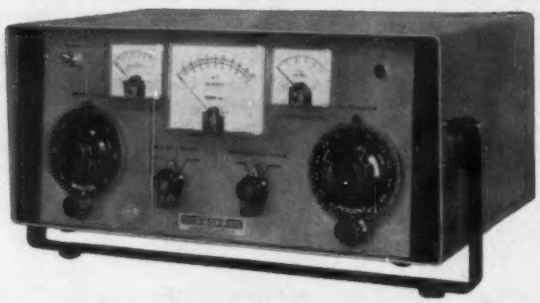

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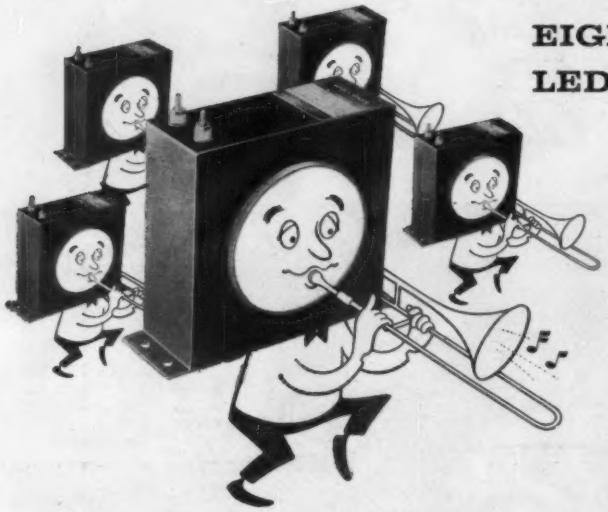

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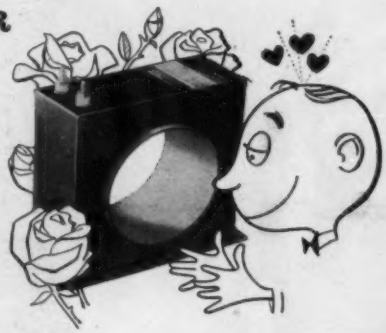

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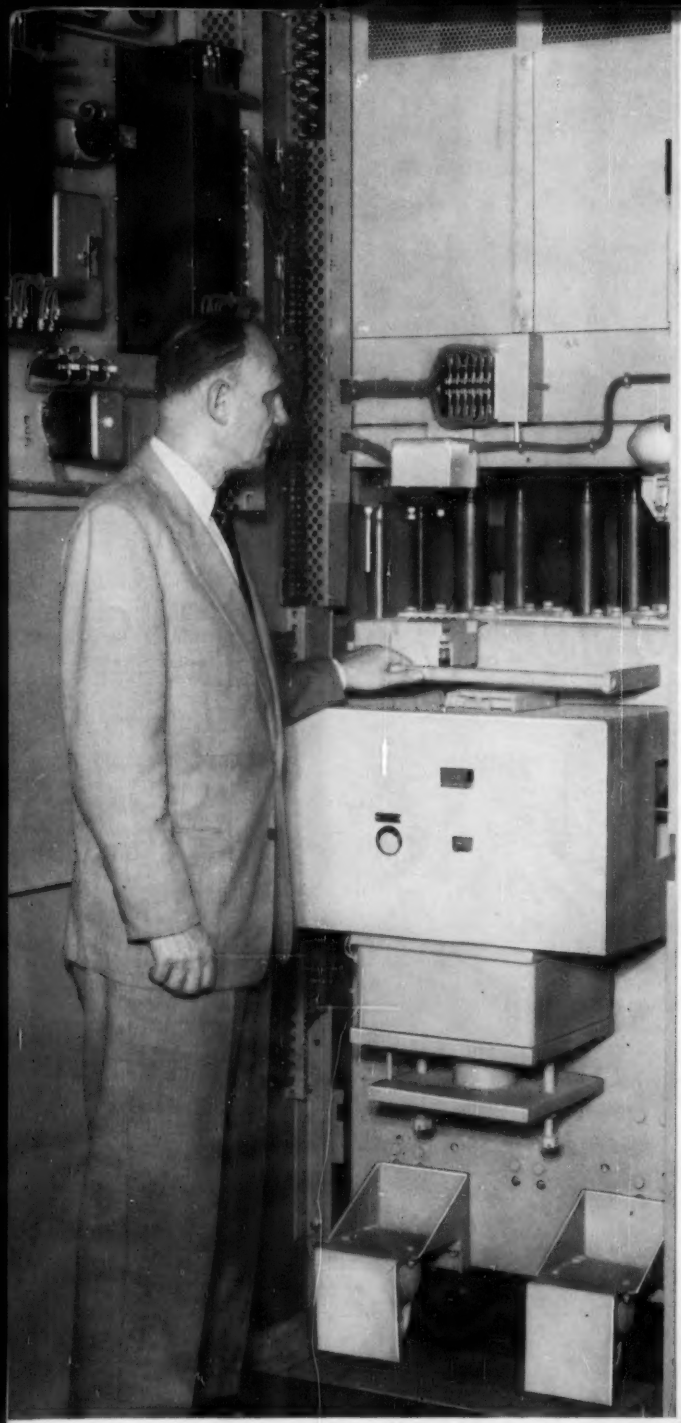

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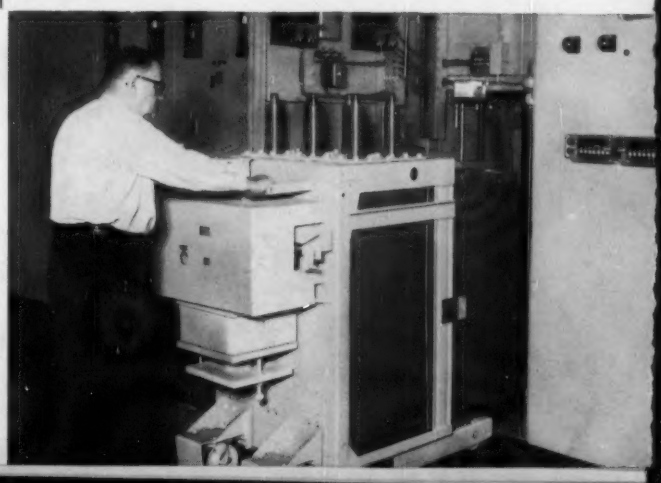
"VISUAL-BREAK" OPERATION greatly simplifies breaker handling during inspection and maintenance. Operators can see when primary disconnects are parted—for safe breaker removal. Breaker's lower center of gravity minimizes the danger of breaker tip-over.



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